Sonicator® Plus 992

Maintenance Manual

METTLER ELECTRONICS® corp.

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Table Of Contents

Section	Title	Page
1	**Introduction**	**5**
2	**Symbol Glossary and List of Abbreviations**	**7**
2.1	Symbol Glossary	7
2.2	Treatment Status Indicator Icons	9
2.3	List of Abbreviations	11
3	**Specifications**	**13**
3.1	General Specifications	13
3.2	Ultrasonic Generator Specifications	14
3.3	Ultrasonic Applicator Specifications	15
3.4	Waveform Specifications	17
3.5	Amplitude Modulation Specifications	20
4	**Precautions**	**21**
5	**Equipment Description**	**23**
6	**Theory of Operation**	**25**
7	**Installation Instructions**	**27**
8	**Operating Instructions**	**29**
8.1	A Note About Electrodes	29
8.2	General Operating Instructions	30
8.3	General Set-up Procedure	30
8.4	Stimulation Set-up Procedure	31
8.5	Ultrasound Set-up Procedure	34
8.6	Combination Therapy Set-up Procedure	36
8.7	Electrode Positioning	39
9	**Maintenance and Troubleshooting**	**41**
9.1	Cleaning the Sonicator Plus 992	41
9.2	Routine Maintenance	41
9.3	Troubleshooting the Sonicator Plus 992	41
10	**Test And Calibration Procedure**	**45**
10.1	Required Equipment	45
10.2	Preliminary Tests	45
10.3	Diagnostic Tests	46
10.4	Ultrasound Output Tests	48
10.5	Ultrasound Error Tests	49
10.6	Stimulation Treatment Mode Output Tests	49
10.7	Stimulation Recip and Surge Tests	53
10.8	Stimulation Error Tests	53
10.9	EEProm Memory Test	54
10.10	Combination Output Tests	54
10.11	Input Current Test	54
10.12	Burn-In	55
10.13	Final Adjustment	55
10.14	Safety Tests	55
10.15	Final Operational Check	56
11	**Parts Replacement**	**57**
11.1	Chassis Disassembly	57
11.2	Bottom Cover Removal	57
11.3	Chassis Bottom Components Servicing	57
11.4	Chassis Top Components Servicing	58
12	**Parts**	**61**

13 Accessories 63
13.1 Ordering Information 63
13.2 Sonicator Plus Accessories 63
Appendix A Measuring Ultrasound Power Output 65
Appendix B Ultrasound Applicator Repair 66
Appendix C Result Codes for Keyboard Test 67

List of Figures

No.	Title	Page
1.1	Sonicator Plus 992 and Accessories	5
3.1	Pulse Waveform—20% Duty Cycle	14
3.2	Pulse Waveform—50% Duty Cycle	14
3.3	Continuous Waveform	15
3.4	10 cm² Applicator (1 MHz), ME 7310—Three Dimensional Beam Pattern	15
3.5	5 cm² Applicator (1 MHz), ME 7513—Three Dimensional Beam Pattern	16
3.6	5 cm² Applicator (3.2 MHz), ME 7513—Three Dimensional Beam Pattern	16
3.7	1 cm² Applicator (3.3 MHz), ME 7331—Three Dimensional Beam Pattern	16
3.8	Interferential Waveform (Sine Wave)	17
3.9	Premodulated Waveform	17
3.10	Medium Frequency Waveform (Russian)	18
3.11	Biphasic *(TNS)* Waveform	18
3.12	High Volt Waveform	19
3.13	Microcurrent Waveform	19
6.1	Sonicator Plus 992 Block Diagram	26
7.1	Sonicator Plus 992, Rear view, Mains Power Switch and Line cord connections	28
7.2	Sonicator Plus 992, Front View—Electrode Cable and Ultrasound Applicator Connections	28
7.3	Connecting the Applicator to the Universal Applicator Cable	28
8.1	Front membrane panel and LED indicators	29
8.2	Electrode Sizes and Current Density	30
8.3	Quadpolar Electrode Placement Technique	39
8.4	Bipolar Electrode Placement Technique	39
8.5	Monopolar Electrode Placement Technique	40
8.6	Using the Pencil Electrode	40
B.1	Applicator Top Assembly	66

Section 1—Introduction

Sonicator Plus 992 servicing should be done at the factory.

If it is not possible to return the Sonicator Plus 992 to the factory, this service manual may be used to troubleshoot to the major subassembly level. Discrepant subassemblies can then be repaired by ordering them from the factory as an alternative to returning the complete system.

This manual is intended for service technicians who perform preventive and corrective maintenance on medical devices using appropriate electronic test and measurement equipment. It should be read in its entirety before attempting to service the Sonicator Plus 992.

For technical assistance, call our Service Department at:

Toll Free:	(800) 854–9305, USA
Phone:	1 (714) 533–2221
FAX:	1 (714) 635–7539

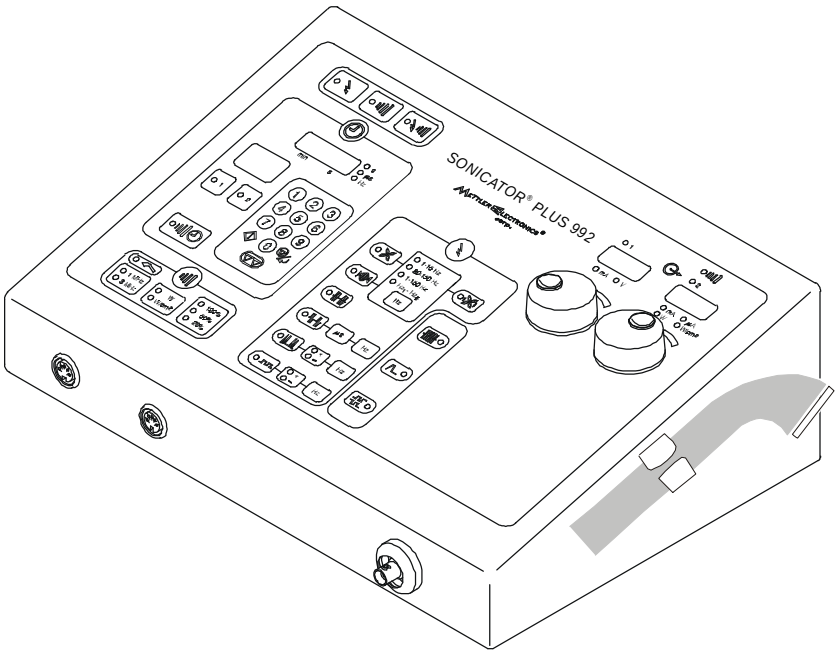
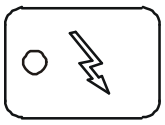


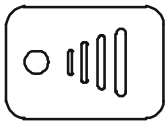
Figure 1.1—Sonicator Plus 992

Section 2—Symbol Glossary and List of Abbreviations

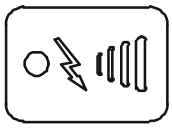
2.1 Symbol Glossary



Electrical Stimulation Selector



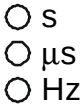
Therapeutic Ultrasound Selector



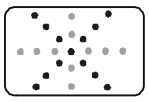
Combination Therapy Selector

Time display

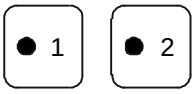
Time display LED's. Displays treatment time and numeric values for frequency, phase duration, on/off times and alphanumeric error codes.



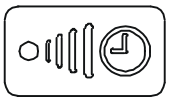
These LED's will illuminate to prompt the clinician to input either time in seconds or microseconds or frequency in Hz. The time or the frequency will be displayed in the numeric time display.



Treatment Status Indicator



Channel display indicator and selector



Ultrasound display indicator and selector

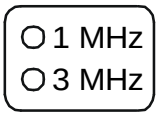
Numeric keypad for time, frequency or phase duration entry.

Starts treatment and stimulation or ultrasound output.

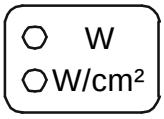
Stops treatment for the treatment displayed in timer window or acts as an "Enter" button during treatment setup.

Stops all ultrasound and stimulation output.

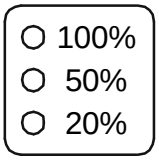
Active ultrasound output indicator on solid when ultrasound output is present, flashing when coupling is inadequate.



Frequency selector for 5 cm² 1 and 3 MHz applicator. Displays frequency for all applicators.

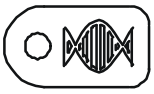


Ultrasound output display selector

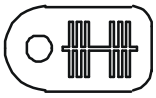


Ultrasound duty cycle selector

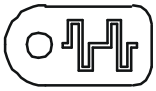
Interferential waveform selector—LED is illuminated when this function is activated.



Premodulated waveform selector—LED is illuminated when this function is activated.

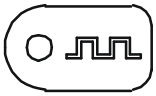


Medium frequency waveform selector—LED is illuminated when this function is activated.

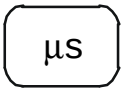


Symmetrical biphasic *(TNS)* waveform selector—LED is illuminated when this function is activated.

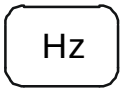
High volt waveform selector—LED is illuminated when this function is activated.



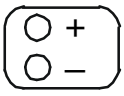
Microcurrent waveform selector—LED is illuminated when this function is activated.



Phase duration control selector—Press this button during a biphasic *(TNS)* treatment to display phase duration.

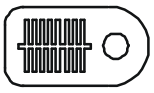


Frequency control selector—Press this button during a stimulation treatment to display frequency.



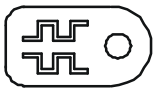
Polarity selector for high volt and microcurrent waveforms.

Amplitude modulation (*Vector rotation*) used for interferential waveform only. LED is illuminated when this function is activated.

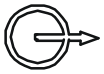


Continuous stimulation selector

Surge selector to set on and off times



Reciprocation selector, use for channel pair 1 & 2

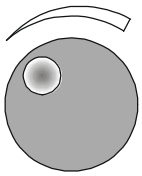


Stimulation or ultrasound output displays

LED's that display the output intensity during a treatment. When the unit is in the "Hold" mode for electrical stimulation, *or ultrasound for CE models*, "------" will be displayed. When the unit is in the "Hold" mode for therapeutic ultrasound, the output intensity will be displayed but the "Active Ultrasound Output" indicator will be off and the timer will not be running.

LED indicators are lit to define which output intensity is being displayed in the two windows.

LED indicators are lit to show the measurement units of the output intensity being displayed in the window.



Output intensity control knob, rotate knob clockwise to increase output and counterclockwise to decrease output.

I

Mains On.

O

Mains Off.

Attention, consult instruction manual.

Type BF Equipment—Class I

IPX0

Not suitable for use in the presence of a flammable anesthetic mixture with air or with oxygen or nitrous oxide.

IPX7

Protected against the effects of immersion.

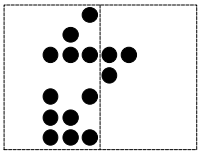
ETL Listed

C–ETL Listed

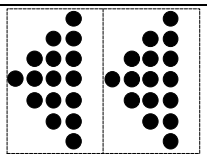
CE 0197

CE Mark

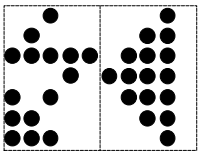
2.2 Treatment Status Indicator Icons



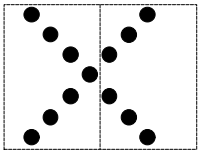
Stimulation selected, waiting for waveform type to be selected.



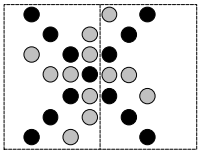
Ultrasound selected



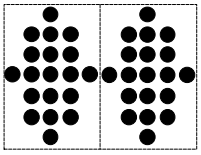
Combination therapy selected, waiting for waveform type to be selected.



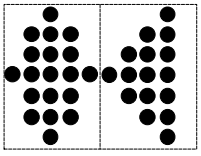
Interferential waveform selected. Display will move to the right when the outputs are active.



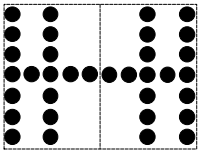
Interferential vector rotation control selected. Display appears to rotate.



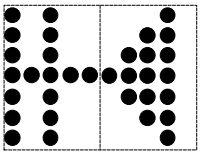
Premodulated waveform selected. Display will move to the right when the outputs are active.



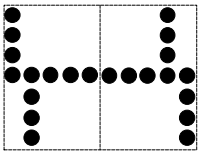
Premodulated waveform selected for combination therapy. Display will move to the right when the outputs are active.



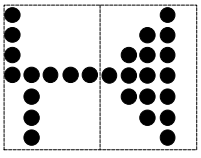
Medium frequency *(Russian)* waveform selected. Display will move to the right when the outputs are active.



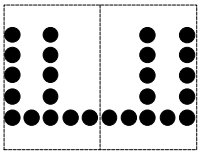
Medium frequency *(Russian)* waveform selected for combination therapy. Display will move to the right when the outputs are active.



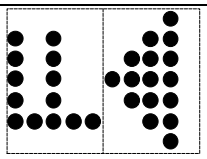
Biphasic *(TNS)* waveform selected. Display will move to the right when the outputs are active.



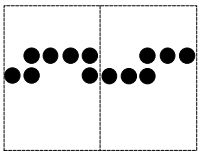
Biphasic *(TNS)* waveform selected for combination therapy. Display will move to the right when the outputs are active.



High volt waveform selected. Display will move to the right when the outputs are active.



High volt waveform selected for combination therapy. Display will move to the right when the outputs are active.



Microcurrent waveform selected. Display will move to the right when the outputs are active.

2.3 List of Abbreviations

cm^2	—	Square centimeters
Hz	—	Hertz (pulses per second)
LED	—	Light Emitting Diode
MHz	—	Megahertz (1×10^6 cycles per second)
µA	—	Microampere (1×10^{-6} ampere)
µs	—	Microsecond (1×10^{-6} second)
mA	—	Milliampere (1×10^{-3} ampere)
ms	—	Millisecond (1×10^{-3} second)
min	—	Minutes
s	—	Seconds
S/N	—	Serial Number
V	—	Volts
W	—	Watts
W/cm^2	—	Watts per square centimeter

Section 3—Specifications

3.1 General Specifications:

Input:	90–240 VAC, 50–60 Hz, 2.3 Amp. Nom.
Certification: *Domestic model*	The Sonicator Plus 992 complies with the ultrasound performance standards set forth in the Code of Federal Regulations, Title 21 (Food and Drugs), Part 1050.10 and IEC 601-2-5, 1st Ed., 1984
ETL and C-ETL Listed:	Model ME 992 (9801427)
Classification: *CE model*	Protective Class I Equipment Type BF Equipment
	Enclosed equipment without protection against ingress of water.
	Equipment not suitable for use in the presence of a flammable anesthetic mixture with air or with nitrogen oxide
Year 2000 Compliant	Yes
U.S. Patent Numbers:	U.S. and foreign patents applied for and granted including U.S. Patent Numbers 4,966,131 and 5,095,890.
Weight:	8.9 pounds 4,0 kg
Dimensions:	5 in (H) x 14.5 in (W) x 10 in (D) 12.7 cm (H) x 36.8 cm (W) x 25.4 cm (D)
Operating Temperature:	+50°F to +104°F +10°C to +40°C
Humidity:	Operating, 30% to 75% Relative Humidity at 104°F (40°C) Nonoperating, 5 to 95% Relative Humidity, non-condensing
Storage Temperature:	-40°F to 167°F -40°C to 75°C
Storage Humidity:	Storage, 30% to 90% Relative Humidity at 40° C, Non-condensing
Storage Pressure:	700-900 mB
Environmental Disposal:	The device contains lead in the form of solder used to produce electrical contact between components. To avoid adverse environmental impact, utilize a disposal facility that performs complete incineration of the device at a temperature in excess of 1000°C.
	The shipping materials are fabricated of cardboard and may be disposed of with other paper products.
Treatment timer:	
Timer Accuracy:	±0.5 minutes for times less than 5 minutes ±10% for times from 5 to 10 minutes ±1.0 minute for times greater that 10 minutes
	±5%, *CE specification*
Maximum Treatment Time:	60 minutes–electrical stimulation 30 minutes–ultrasound or combination therapy

Treatment Timer:	Treatment time counts down to zero when a time is set, or up to 60 or 30 minutes when no time is set. The digital timer indicates time in minutes and seconds. The timer also indicates the remaining or elapsed treatment time during the "Hold" period.

3.2 Ultrasonic Generator Specifications:

Frequency:	1.0 MHz ±5% 3.2 MHz ±5% 3.3 MHz ±5%
Modes:	Continuous Pulsed—20% duty cycle Pulsed—50% duty cycle
Modulation:	100%
Modulation Waveform:	Rectangular
Pulse Repetition Rate: *Modulation Frequency*	100 Hz ±20%
Pulse Duration: *Modulation Period*	2 msec ±20%, 20% duty cycle 5 msec ±20%, 50% duty cycle
Temporal Peak / average intensity ratio:	5:1 ±20%, 20% duty cycle 2:1 ±20%, 50% duty cycle
Maximum output power:	22 W with a 10 cm² applicator, (ME 7310) 11 W with a 5 cm² applicator, (ME 7513) 2.2 W with a 1 cm² applicator (ME 7331)
Maximum intensity:	2.2 W/cm² with all applicators
Indication accuracy:	±20% (for any level above 10% of maximum)
Output description:	The output waveform is continuous or pulsed as programmed by the membrane panel control. In the pulse mode the 1, 3.2 or 3.3 MHz square wave pulses are modulated. The power level is adjusted by varying the pulse amplitude. The pulse waveforms are shown below:

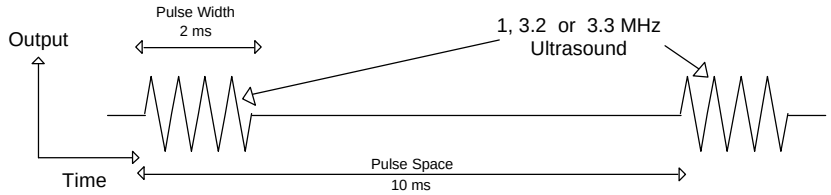


Figure 3.1—Pulse Waveform—20% Duty Cycle

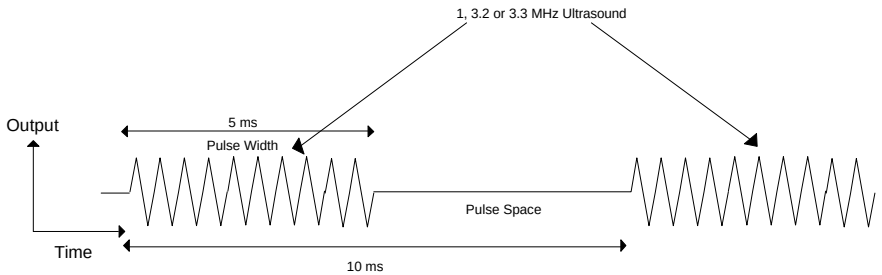


Figure 3.2—Pulse Waveform—50% Duty Cycle

In the continuous mode, the power is on at least 95% of the time the timer is running. The continuous mode waveform is shown below:

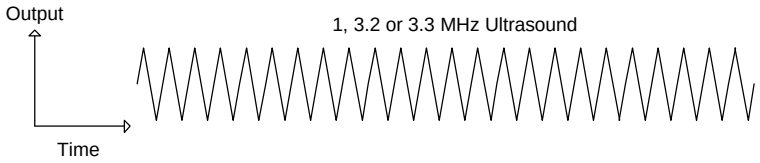


Figure 3.3—Continuous Waveform

3.3 Ultrasonic Applicator Specifications:

Piezoelectric discs: The output transducer utilizes a barium titanate disc with a specially coated face.

Individual Applicator Specifications:

Applicator Part Number	Frequency	Effective Radiating Area
ME 7310	1 MHz ±5%	10 cm²±10%
ME 7331	3.3 MHz ±5%	1 cm² ±10%
ME 7513	1 or 3.2 MHz ±5%	5 cm² ±10%

Maximum Beam Non–Uniformity Ratio: 6:1

Maximum Effective Intensity Ratio: 2:1

Spatial Pattern: The applicator produces a collimated (cylindrical) beam with an area of 1, 5 or 10 cm^2, measured 5 mm from the ceramic disc surface when the radiation is emitted into the equivalent of an infinite medium of distilled water at 30° C.

The beam of the applicator is circular in all planes parallel to the applicator face. A few inches from the face, it is a single smooth bell-shaped curve. Nearer the face the pattern varies more due to phase cancellations. Sample curves measured in the far field from the surface are shown in Figures 3.3, 3.4, 3.5 and 3.6.

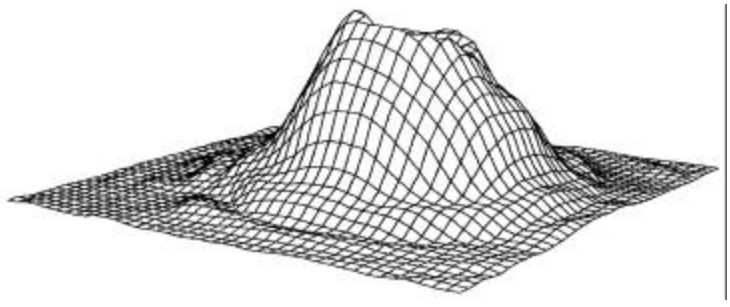


Figure 3.4—10 cm² Applicator (1 MHz), ME 7310,—Three Dimensional Beam Pattern

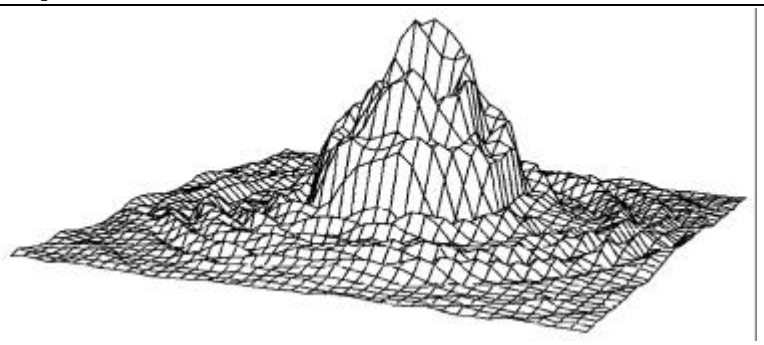


Figure 3.5—5 cm² Applicator (1 MHz), ME 7513,—Three Dimensional Beam Pattern

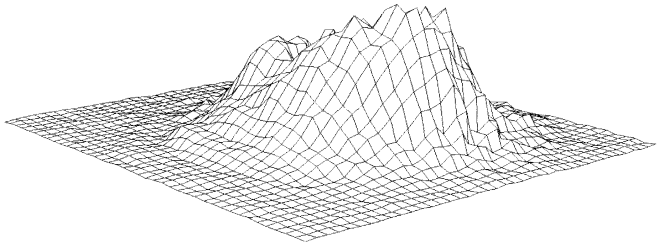


Figure 3.6—5 cm² Applicator (3.2 MHz), ME 7513,—Three Dimensional Beam Pattern

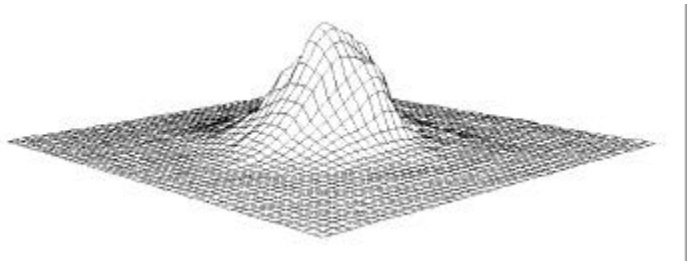


Figure 3.7—1 cm² Applicator (3.3 MHz), ME 7331,—Three Dimensional Beam Pattern

3.4 Waveform Specifications:

Interferential Mode

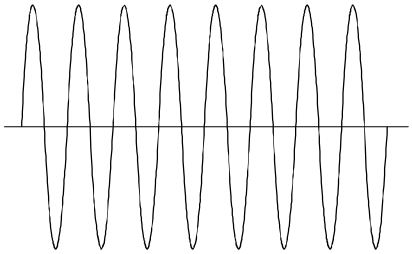


Figure 3.8—
Interferential Waveform

Waveform Type:	Sinewave
Polarity:	None
Volts:	0–65 volts RMS, 1 Kohm load
Current:	0–65 mA RMS, 1 Kohm load
Average current at maximum intensity and frequency:	65 mA RMS
Maximum current density under 2" diameter electrode.	3.2 mA/cm²
Frequency:	Channel 1 = 4000 Hz Channel 2 = 4000 to 4250 Hz variable frequency sine wave
Frequency Modulation:	1–15 Hz 80–150 Hz 1–150 Hz xx–xx Hz, *xx=any value from 1 to 250 Hz*
Phase Duration:	125 µs
Available Amplitude Modulation Options:	Vector rotation
Available Channels:	Channel 1 & 2

Premodulated Mode

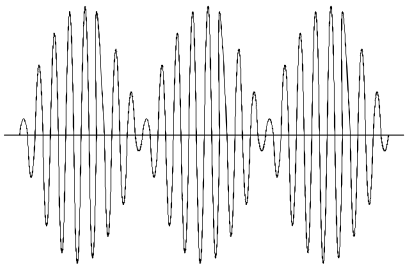


Figure 3.9—Premodulated
Waveform

Waveform Type:	Amplitude modulated sine wave
Polarity:	None
Volts:	0–50 volts RMS, 1 Kohm load
Current:	0–50 mA RMS, 1 Kohm load
Average current at maximum intensity and frequency:	50 mA RMS
Maximum current density under 2" diameter electrode:	2.5 mA/cm²
Frequency:	4,000 Hz
Frequency Modulation:	1–15 Hz 80–150 Hz 1–150 Hz xx–xx Hz, *xx=any value from 1 to 250 Hz*
Phase Duration:	125 µs internal sine wave 4–1,000 ms beat envelope
Available Amplitude Modulation Options:	Continuous Surge Reciprocation
Available Channels:	All

Medium Frequency Mode

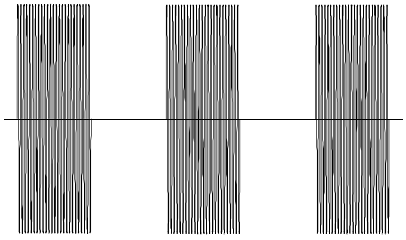


Figure 3.10—Medium Frequency (*Russian*) Waveform

Waveform Type:	Burst modulated sine wave
Polarity:	None
Volts:	0–50 volts RMS, 1 Kohm load
Current:	0–50 mA RMS, 1 Kohm load
Average current at maximum intensity and frequency:	50 mA RMS
Maximum current density under 2" diameter electrode.	2.5 mA/cm²
Frequency:	2500 Hz, Burst at 10 ms on and 10 ms off
Frequency Modulation:	No
Phase Duration:	200 µs
Available Amplitude Modulation Options:	Continuous Surge Reciprocation
Available Channels:	All

Biphasic *(TNS)* Mode

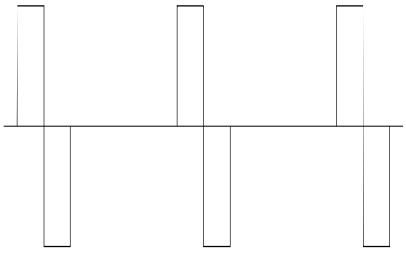


Figure 3.11—Biphasic *(TNS)* Waveform

Waveform Type:	Symmetrical biphasic square wave
Polarity:	None
Volts:	99 volts peak, 1 Kohm load
Current:	0 –99 mA peak, 1 Kohm load
Average current at maximum intensity and frequency:	7.2 mA
Maximum current density under 2" diameter electrode.	0.36 mA/cm²
Frequency:	1–120 Hz
Frequency Modulation:	No
Phase Duration:	50–300 µs
Available Amplitude Modulation Options:	Continuous Surge Reciprocation
Available Channels:	All

High Volt Mode

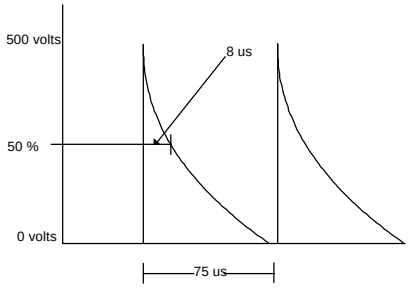


Figure 3.12—High Volt Waveform

Waveform Type:	Monophasic twin peak
Polarity:	Positive or negative
Volts:	500 volts peak, 1 Kohm load
Current:	0–500 mA peak, 1 Kohm load
Average current at maximum intensity and frequency:	1.2 mA at 120 pps with 1 Kohm load
Maximum current density under 2" diameter electrode.	0.06 mA/cm²
Frequency:	1–120 Hz
Frequency Modulation:	No
Phase Duration:	8 µs at 50% Vmax
Polarity:	Positive or negative
Available Amplitude Modulation Options:	Continuous Surge
Available Channels:	Channel One only

Microcurrent Mode

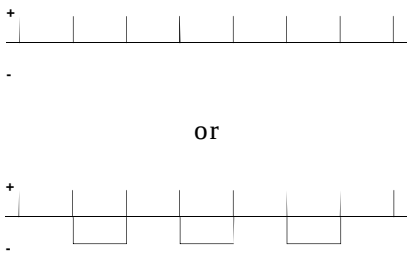


Figure 3.13—Microcurrent Waveform

Waveform Type:	Monophasic or biphasic square wave
Polarity:	Positive or negative or biphasic pulses
Volts:	1 Volt peak, 1 Kohm load
Current:	10-990 µA peak, 1 Kohm load
Average current at maximum intensity and frequency:	990 µA
Maximum current density under 2" diameter electrode.	24.4 µA/cm²
Frequency:	0.5-500 Hz
Duty Cycle:	50%
Frequency Modulation:	No
Pulse Duration:	1-1000 ms
Available Amplitude Modulation Options:	Continuous
Available Channels:	Channel Two only

3.5 Amplitude Modulation Specifications:

Vector rotation:	*Interferential Mode Only*
	-50% amplitude modulation in anti phase with an eight second modulation period.

Surge Mode:	*Premodulated, Medium Frequency and Biphasic (TNS) Pulsed Modes*
Up ramp:	3 seconds
Down ramp:	2 seconds
Preset on/off times:	10 seconds on, 10 seconds off 10 seconds on, 20 seconds off 10 seconds on, 30 seconds off 10 seconds on, 40 seconds off 10 seconds on, 50 seconds off 10 seconds on, 60 seconds off
Programmable On time:	1–240 seconds
Programmable Off time:	1–240 seconds

Reciprocation mode:	*Premodulated, Medium Frequency and Biphasic (TNS) Pulsed Modes*
Up and down ramps:	1 second, *reciprocation only*
Reciprocation time:	2–240 seconds, (On time = off time)
Combine with Surge:	Use up and down ramps of surge program Use on/off times of surge program.
Two timer option:	No

Section 4—Precautions

1. Line supply voltage is present inside the enclosure, and present on exposed components after back housing is removed if line cord is connected to the line supply. DISCONNECT LINE CORD PRIOR TO REMOVING BACK COVER.
2. Qualified technicians using appropriate calibrated test equipment should perform servicing.
3. Use grounded wall outlets only.
4. Adhere to standard safety practices for troubleshooting and servicing electronic equipment.
5. To insure continued conformance to specifications and applicable safety standards, the Sonicator Plus 992 should be performance checked and safety tested at least once each year.
6. USE OF CONTROLS OR ADJUSTMENTS OR PERFORMANCE OF PROCEDURES OTHER THAN THOSE SPECIFIED HEREIN MAY RESULT IN HAZARDOUS EXPOSURE TO ELECTRICAL ENERGY.
7. Do not operate the Sonicator Plus 992 in close proximity with operating shortwave or microwave diathermies.
8. Replace line fuses with same type and rating as specified in the list of specifications and on the printed circuit board next to the fuses to avoid risk of fire and component damage.
9. Primary circuit components must be replaced with factory- specified components to insure compliance with Safety Standards for Medical and Dental Equipment.
10. Inspect electrodes before use to insure that they do not have damaged areas, which could cause excessive tissue current densities.
11. Properly monitor patient responses to treatment at all times. Discontinue treatment if there are any signs of patient discomfort or distress.
12. Refer to the Instruction Manual for a more complete listing of precautions, warnings, contraindications and side effects/adverse reactions.

Section 5—Equipment Description

The Sonicator Plus 992 is a portable, microprocessor controlled, digital, dual channel, electrical neuromuscular stimulator and ultrasound therapy device that offers a choice of six stimulation pulse output modes. Additional features such as surge options and reciprocation are also available as well as dual frequency, pulsed and continuous ultrasound output.

The welded metal enclosure is divided into two halves, a top half and a bottom half. Electronics circuitry and indicator subassemblies are assembled into the top enclosure half. The bottom enclosure half provides a protective cover and base that is removed by means of fourteen Phillips head screws.

There are two printed circuit boards in the Sonicator Plus 992: the main circuit board with the displays and the power supply board. The power supply board holds the two primary fuses. Each of these subassemblies is described in the Theory of Operation section of this manual.

The membrane touch control panel incorporates multilayer laminated design pushbutton switches with international symbols for maximum readability. There are two continuous rotation knobs or dials, which allow for adjustment of all output intensities.

Displays consist of 7-segment LED's, a dot matrix waveform monitor display, green status indicator LED's, and an audible beeper signal to indicate control operation, end of treatment time, and output cutoff.

The Sonicator Plus is constructed and safety tested in compliance with international standards for electrical safety and electromagnetic compatibility.

Section 6—Theory of Operation

The Sonicator Plus 992 is a sophisticated microprocessor controlled, variable frequency, variable amplitude, multi-channel muscle stimulation signal and ultrasound output generator. It takes line voltage, which is transformed down to lower voltages and converts this voltage to regulated DC voltages, which are used internally for powering the circuitry. This function is performed by the circuitry on the power supply circuit board.

The mains supply voltage enters the instrument by means of a 3 prong IEC standard power connector from the hospital grade line cord supplied with the instrument. After passing through the power switch and an AC line RFI filter, the line voltage is applied to the fused switching power supply circuit board. This board converts the line voltage to regulated DC ±18 VDC and ±5 VDC for the low level analog and digital circuitry and to +38 VDC for the ultrasound output circuitry. These voltages are delivered from the power supply circuit board to the main circuit board by means of a 12-conductor ribbon cable.

The main circuit board is mounted immediately behind the front panel and is connected to five cable assemblies. The previously mentioned 12-conductor ribbon cable delivers DC from the power supply board. The membrane switch signals are connected to the main board by mini ribbon cable to a ZIF connector. The output signals are connected to the bulkhead receptacles by means of 2-conductor cables for stimulation outputs and a coaxial BNC connector for ultrasound output to the applicator.

The main board mounts 10 seven-segment LED displays for time and output indications behind the front panel display filters. A display driver chip interfaced to the main microprocessor data buss drives the individual mode indicator displays and seven segment displays. Likewise, dual dot matrix displays are also mounted behind the front panel and driven by a dedicated display driver chip.

The main system processor, an MC68HC11 microprocessor operating at 8 MHz executes instructions contained in read only memory. It scans the keyboard for user inputs and executes instructions in response to these user inputs. It communicates with two other microprocessors, which are used to generate the actual waveforms. These waveforms are programmed into the second microprocessor's read only memory. All signals are digitally synthesized using sophisticated waveform generation algorithms thereby eliminating the circuit drift and performance limitations of analog waveform generating circuitry. The main system microprocessor also controls the ultrasound output signals and performs the applicator auto-tuning function

Amplitude and frequency selections are sent to a dual channel power amplifier, which couples these signals through output isolation transformers to the patient connected electrodes. Voltages and currents delivered to the transformer primary are closely monitored by the main microprocessor. Unintended changes in voltage or current delivered to the transformers are sensed and corrective action is taken by the microprocessor. Error messages are generated on the display to alert the user to these conditions. In certain cases the output is disconnected from the patient by breaking the secondary circuit of the output isolation transformer. The transformer can only couple AC voltages to a patient. A transformer cannot couple a DC voltage.

While primary circuit monitoring is very effective in limiting output current and voltage, there is no way that the muscle stimulator can know or sense the conditions of the electrodes or the patient skin to electrode conditions. For these reasons it is important to monitor the electrode quality and patient properly.

Ultrasound output originates as a digitally synthesized 1 or 3 MHz signal that is upconverted and filtered to correct levels for driving the ultrasound applicator. The output current is monitored at all times to insure that the user determined output power levels are actually being delivered to the patient at all times. The output frequency of the applicator is constantly monitored and fine-tuned if there is any deviation from the desired frequency.

Sonicator Plus 992
System Block Diagram

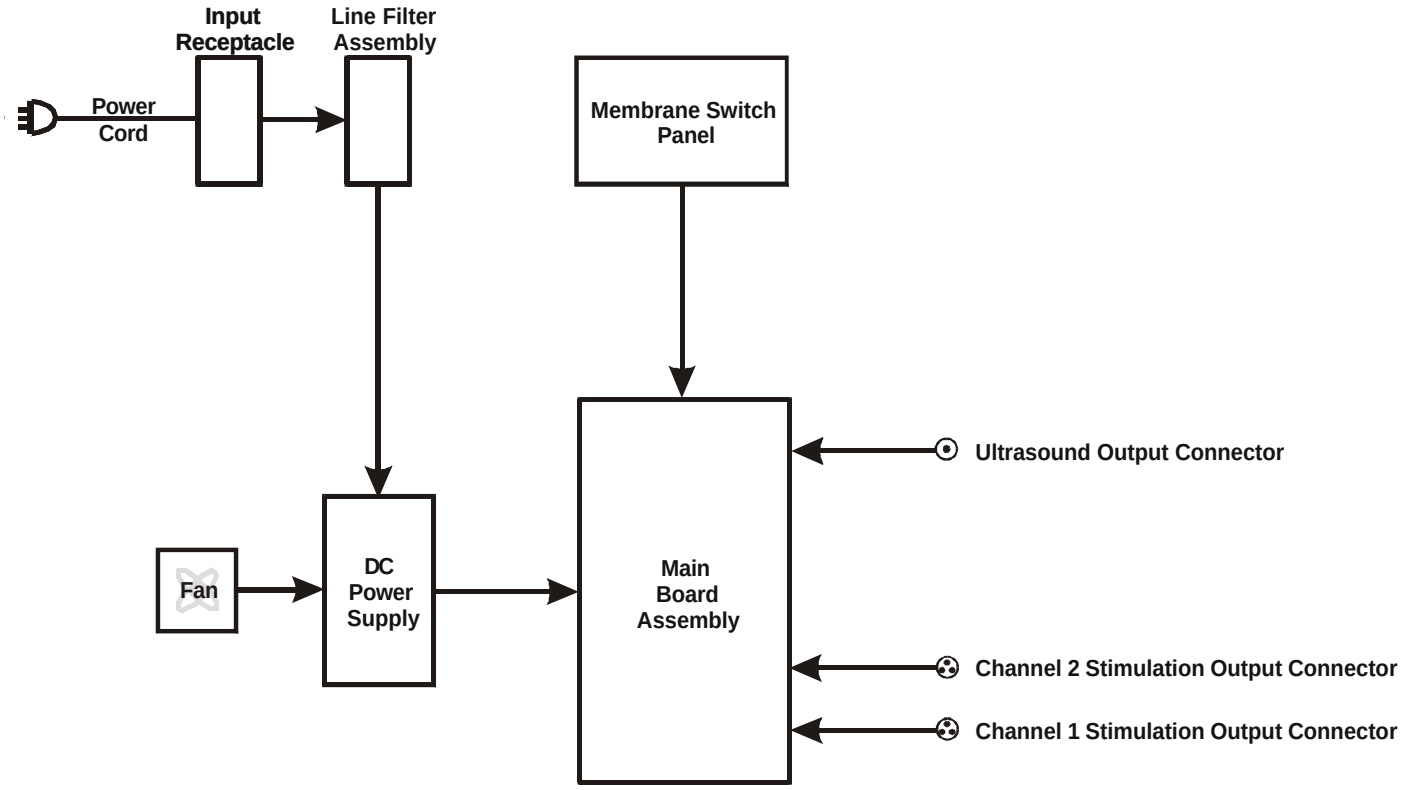


Figure 6.1—Sonicator Plus 992 Block Diagram

Section 7—Installation

7.1 Installation Instructions

1. Connect the line cord to the back of the Sonicator Plus 992. (See Figure 7.1)
2. Plug the line cord (ME 7293, *domestic model* or ME 7296, *CE model*) into a grounded wall outlet that is rated between 90–240 VAC, 50–60 Hz. Your power supply must match the voltage requirements listed on the serial number label of your device. **Do not connect the** Sonicator Plus 992 **to a power supply rated differently than that described above.**
3. The line cord comes equipped with a standard 3–prong plug. This plug provides grounding for the Sonicator Plus 992. Do not defeat its purpose by using 3–to–2 prong adapters or any other means of attaching to a wall outlet. *CE models may require a different plug. However, grounding is required.*
4. Push the hooded, waterproof applicator cable connector (ME 7392) into the round BNC receptacle located on the front of the Sonicator Plus 992. (See Figure 7.2) Connect applicator to universal applicator cable using the BNC connector. (See Figure 7.3) Secure both connectors by turning the outside ring ¼ turn clockwise. To maintain waterproof characteristics of the BNC connectors make sure that all connections are dry before attempting to connect them. ***Please Note:*** *The applicator model 7513, comes standard with the Sonicator 992. Other applicators that may be used with the Sonicator Plus 992 are the models 7305, 7331, 7310 and 7335. Verify that the applicator is labeled for use with the Sonicator Plus 992 before attaching it to the unit. This information is contained on the applicator label.*
5. Place the applicator into the applicator clamp. It may be attached to the back as seen in Figure 7.1 or to the side as seen in Figure 1.1.
6. Plug the electrode cables (ME 2260) into the electrode cable connections as seen in Figure 7.2. For combination therapy procedures, plug the single line electrode cable (ME 2261) into the electrode connection for Channel 1.
7. The Sonicator Plus 992 may be susceptible to interference originating from shortwave diathermy units operating in close proximity to it. Avoid operating the Sonicator Plus 992 adjacent to and simultaneously with operating shortwave devices.
8. **Do not use sharp objects to operate the membrane panel switches.** If the tough outer layer of the membrane is broken, moisture may leak into the switches resulting in switch failure.
9. Once you have verified proper functioning of your Sonicator Plus 992, using the instructions in Section 8, please fill in the enclosed self–addressed Warranty Registration Card and mail it to Mettler Electronics.

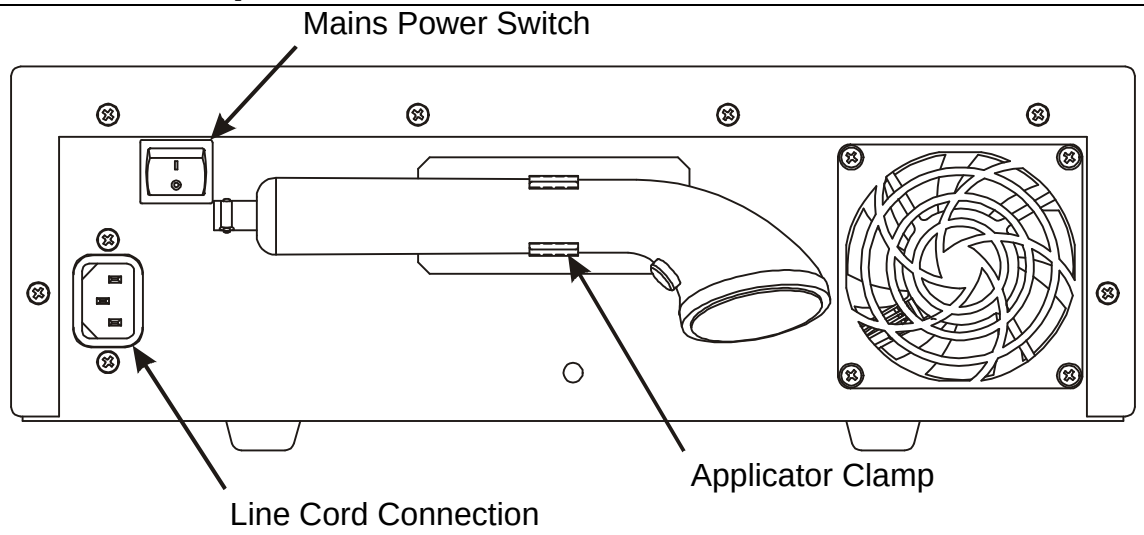


Figure 7.1— Sonicator Plus 992, Back View—
Mains Power Switch, Line Cord Connection and Applicator Clamp

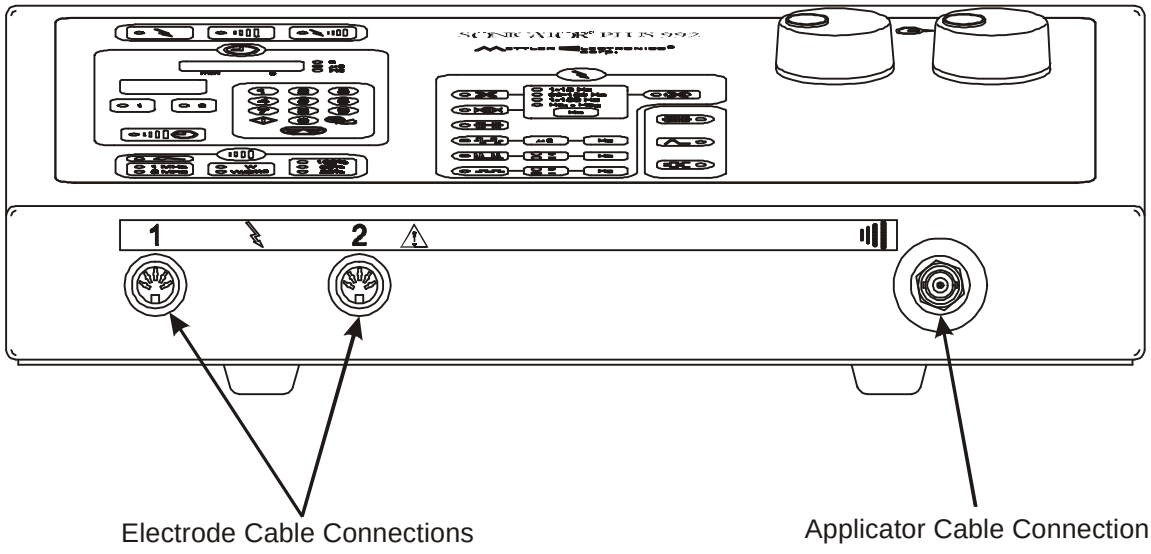


Figure 7.2— Sonicator Plus 992, Front View—
Electrode Cable and Ultrasound Applicator Connections

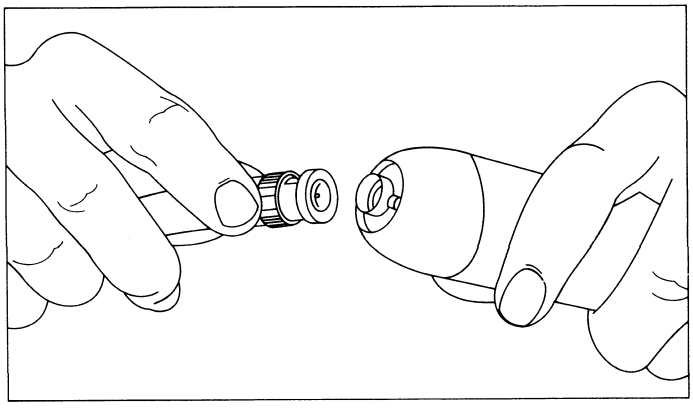


Figure 7.3—Connecting the Applicator to the Universal Applicator Cable

Section 8—Operating Instructions

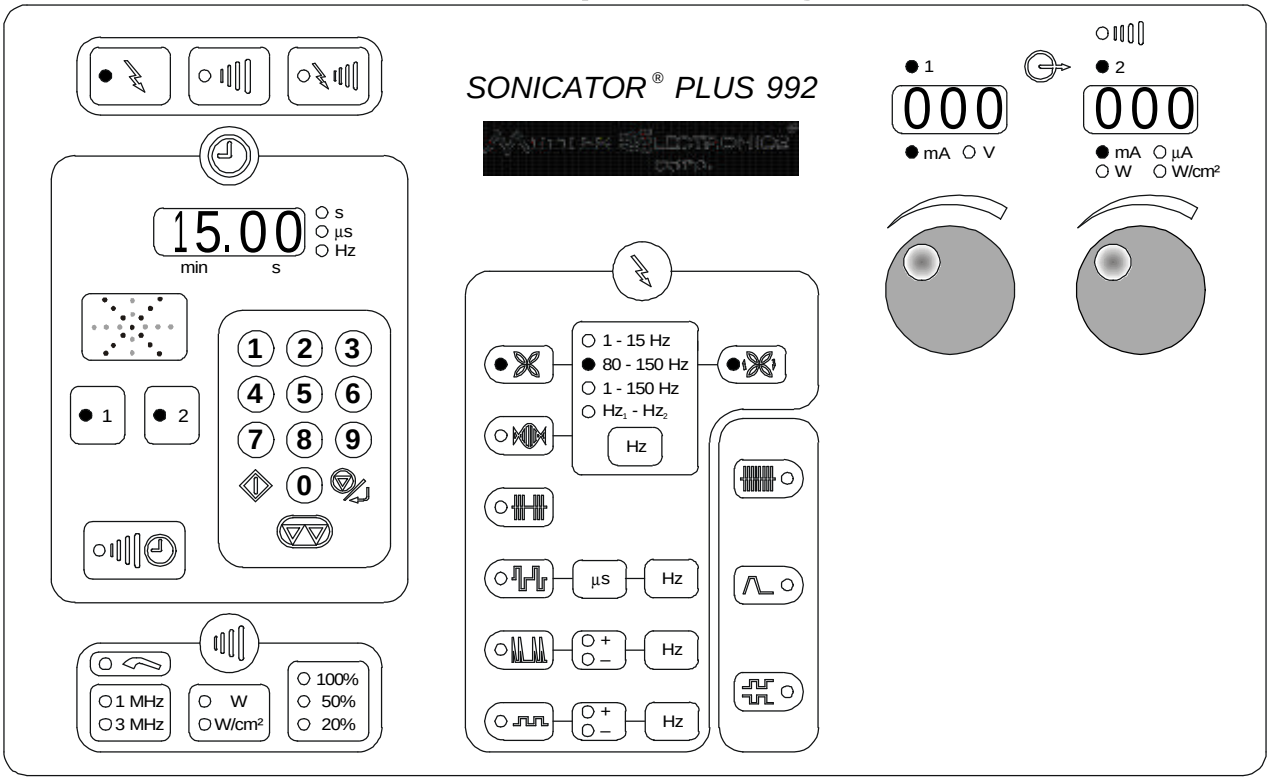


Figure 8.1—Front membrane panel and LED indicators

8.1 A Note about Electrodes

To ensure safe operation of the Sonicator Plus 992, follow the recommendations listed below:

1. We strongly encourage careful maintenance of the electrode system. This includes the lead wires as well as the pads themselves. Worn cables and/or poor pads (or the wrong sized pads) can have a significant impact upon treatment results.
2. Do not exceed the number of recommended uses listed on the instructions for EZ Trodes or other reusable self–adhesive electrodes.
3. Make sure that the entire surface of the electrode is contacting the patient.
4. Do not use moist hot packs to secure electrodes.
5. To avoid skin irritation due to high current density, do not use electrodes smaller in surface area than the 2" *(5.1 cm)* in diameter EZ Trode® self-adhesive electrode (ME 2221).
6. Do not use conductive carbon electrodes with this product.
7. Whenever clinically possible, utilize the largest possible pads to reduce local increases in current density. In situations where small pads are required, use the lowest stimulation intensity necessary to achieve the desired clinical results.

The table below illustrates the relationship between electrode diameter and current density. As you can see the current density increases rapidly when diameter decreases.

Diameter *inches (cm)*	Surface Area *Square inches (cm²)*	Current Density *mA/in² (mA/cm²) (for 10mA)*
1.25 (3,2)	1.2 (10,2)	8.2 (1,0)
2.00 (5,1)	3.1 (26,0)	3.2 (0,4)
3.00 (7,6)	7.1 (57,8)	1.4 (0,2)

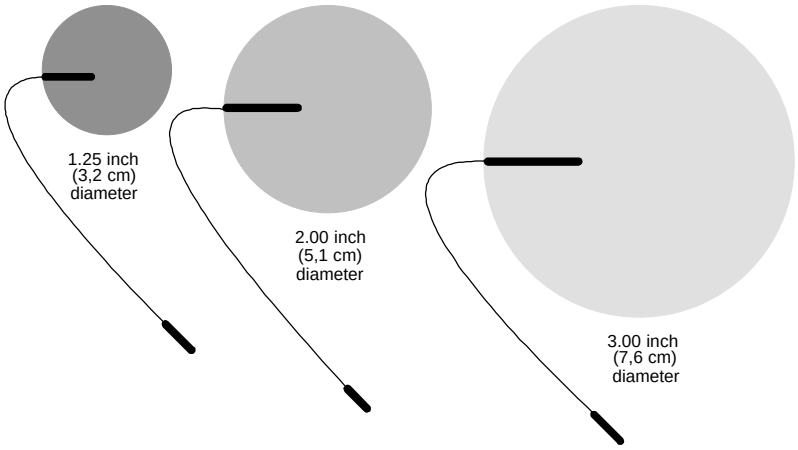


Figure 8.2—Electrode Sizes and Current Density

8.2 General Operating Instructions:

Before you start.

a) Review precautions, contraindications and side effects/adverse reactions listed in Section 5 of the Instruction Manual.

b) Use Mettler Electronics electrodes to ensure safe and effective operation.

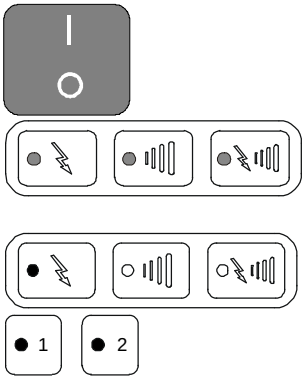
c) Verify connection of the line cord to a grounded wall receptacle and the Sonicator Plus 992.

d) For ultrasound and combination therapy make sure that the applicator is securely connected to the applicator cable and the applicator cable is connected to the Sonicator Plus 992.

e) For combination therapy make sure the single line electrode cable (ME 2261) is attached to electrode cable connection as seen in Figure 7.2. For electrical stimulation connect electrode cables (ME 2260) into the electrode connections for the channels that are going to be used.

f) Note: Descriptions of the symbols used on controls are in Section 2.

8.3 General Set-up Procedure



1. Turn on the mains power switch by pressing "**I**" icon on switch.

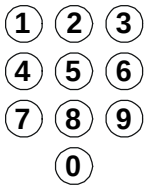
2. When you first turn the Sonicator Plus 992 on, the LED's for treatment selectors will flash. NOTE: *This is how you will know what your choices are when setting up a treatment.*

3. Select the treatment you wish to perform: Electrical Stimulation, Ultrasound or Combination Therapy.

4. The green LED indicators will illuminate for the channel(s) or ultrasound treatments that will be active for this session. Indicators will blink for channels that have already been programmed, but are not being programmed currently.

   To view the parameters for a channel, whose indicators are blinking, press the blinking channel selector button. You will then be able to view selected treatment parameters, treatment output and time remaining or elapsed.

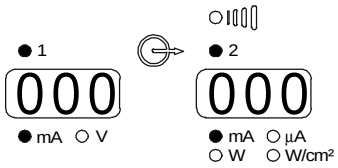
5. Setup the various treatment parameters specific to the treatment you have selected. *Details are listed below.*



6. Select a treatment time using the numeric keypad. For Ultrasound and Combination Therapy the maximum treatment time is 30 minutes. For Electrical Stimulation the maximum treatment time is 60 minutes. If no treatment time is input, the timer will continue to run until the maximum time elapses.

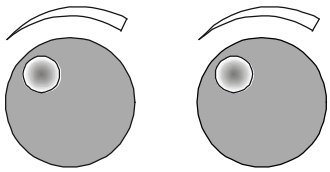
7. For ultrasound and combination therapy apply gel to the treatment area. For electrical stimulation apply electrodes to the patient.

8. Press the start key to begin treatment.



9. Amber LED indicators for the outputs for electrical stimulation and ultrasound will illuminate when you start a treatment. The numeric display shows the output for the selected channel(s) or ultrasound. The green LED indicators located below the numeric display indicate the output units.

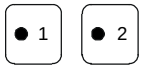
   Flashing amber LED indicators indicate active channel(s) whose output intensity is not currently displayed. If a channel is not active, the numeric display will show "- - -".



10. Adjust treatment output intensity by rotating the knobs clockwise to increase output and counterclockwise to decrease output.

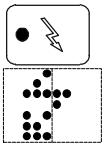
11. Use this button to stop the treatment output that is currently being displayed by the Sonicator Plus 992. All treatment parameters will still be as you programmed them. For ultrasound, the output intensity will also be remembered. For stimulation, you will be required to readjust the output intensity starting at zero if you resume treatment.

12. Use this button to stop all active treatments. Treatment parameters will still be active so you would be able to resume treatment at any time. For ultrasound, the output intensity will also be remembered. For stimulation, you will be required to readjust the output intensity starting at zero if you resume treatment.



13. After the treatment ends, you can press the channel selector to free up the channel(s) for the next treatment selection. Remove the electrodes from the patient and return them to their package for storage. Remove gel residue from the patient's skin.

8.4 Stimulation Set-up Procedure



1. Press the stimulation treatment selector. The Treatment Status Indicator will show you the stimulation icon and all the waveform LED's will begin to blink.

2. Select the stimulation waveform that you would like to use.

Interferential—Channels 1 & 2

Premodulated—Channels 1 or 2

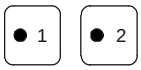
Medium Frequency—Channels 1 or 2

Biphasic *(TNS)*— Channels 1 or 2

High Volt—Channel 1 only

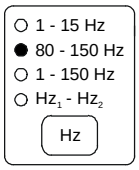
Microcurrent—Channel 2 only

Please Note: Up to two different stimulation protocols may be run simultaneously. The Treatment Status Indicator will show you the icon for the selected waveform.

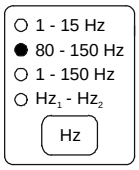


3. For the *interferential* waveform, the Sonicator Plus 992 will automatically pick channels 1 & 2 For the *premodulated, medium frequency and biphasic (TNS)* waveforms, the next available channel will be selected. If a two-channel treatment is desired pick the second member of the channel pair by pressing its button. Channel 1 is automatically selected for the *high volt* waveform and Channel 2 is automatically selected for the *microcurrent* waveform. If a channel is already in use, you will need to free it up before using these two waveforms. Cancel a treatment setup by pressing the channel selector.

4. Set treatment pulse frequency (*Hz*), phase duration (µs) and polarity (+ *or* -) for each waveform.



Interferential—
Choose from preset frequency modulation programs: 1-15, 80-150 or 1-150 Hz or...
Pick Hz_1-Hz_2 to set your own static frequency or frequency sweep range. Enter values for each frequency using the numeric keypad followed by the ⏎ key. The frequency is displayed in the timer window and the Hz LED is lit.



Premodulated—
Choose from preset frequency modulation programs: 1-15, 80-150 or 1-150 Hz or...
Pick Hz_1-Hz_2 to set your own static frequency or frequency sweep range. Enter values for each frequency using the numeric keypad followed by the ⏎ key. The frequency is displayed in the timer window and the Hz LED is lit.

Medium Frequency—
No optional selections

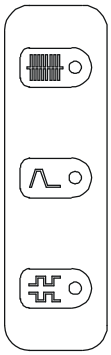
Biphasic *(TNS)***—**
The Sonicator Plus 992 stores the value for the phase duration and the frequency for the last Biphasic *(TNS)* session. If the value displayed in the timer window is acceptable press the ⏎ key.
Set µs for the phase duration, 50-300 µs. Enter a numeric value followed by the ⏎ key.
Set Hz for the frequency, 1-120 Hz. Enter a numeric value followed by the ⏎ key.

High Volt—
Set the treatment polarity. The LED that is lit indicates the red

lead wire's polarity.
Set Hz for the frequency, 1-120 Hz. Enter a numeric value followed by the ⏎ key.

Microcurrent—
Set the treatment polarity. The LED that is lit indicates the red lead wire's polarity. Pressing the button twice will allow the polarity to alternate in a biphasic manner. Both LED indicators will be illuminated.
Set Hz for the frequency, 0.5-500 Hz. Enter a numeric value followed by the ⏎ key, (*05 = 0.5 Hz).*

5. Set options for amplitude modulation—continuous, surge and reciprocation.

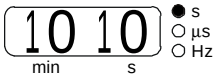


Continuous—no amplitude modulation, no On/Off times, default setting

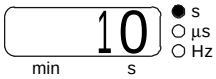
Surge—Set an On and Off time, 3 seconds Up ramp, 2 seconds Down ramp

Reciprocation—Stimulation alternates equally between Channels 1 & 2 or Channels 3 & 4, 1 second Up and Down ramps. May be combined with the Surge option for longer rest times.

Interferential—Continuous
Premodulated—Continuous, Surge and Reciprocation
Medium Frequency, *Russian***—**Continuous, Surge and Reciprocation
Biphasic *(TNS)*—Continuous, Surge and Reciprocation
High Volt—Continuous and Surge
Microcurrent—Continuous



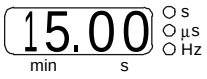
Surge Mode—
Press Surge selector until you see the On/Off duty cycle that you would like to use. Press the ⏎ key to accept the values. Preset On/Off choices are 10 10, 10 20, 10 30, 10 40, 10 50 and 10 60.
If you press the Surge selector one more time after "10 60" is displayed, a single number is displayed. This represents the last On time that was programmed. To change the number, use the numeric keypad to enter a new value followed by the ⏎ key. The Off time is then displayed, enter a new value followed by the ⏎ key.



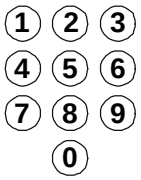
Reciprocation Mode—
To setup a Reciprocation program you must have stimulation setup for two-channel operation. If Channel 1 is lit, press Channel 2.
Press the Reciprocation key. Enter a value from 2 to 240 and press the ⏎ key.

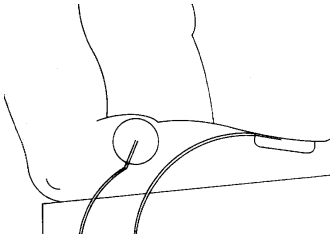
Surge + Reciprocation—

Press Reciprocation key. Press the key. Press the Surge key until you see the On/Off time you want to use. Press the key.



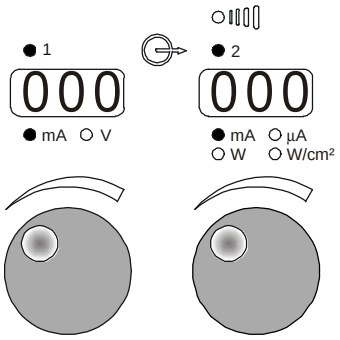
6. Enter the treatment time using the numeric keypad. The maximum treatment time is 60 minutes. If you do not enter a time, the time will count up during a treatment session, but will not exceed 60 minutes.





7. Apply the electrodes to the patient. Attach the electrode cables to the electrodes.

8. Press the start key to begin treatment. The waveform will start to move in the treatment status box and the output display will show 0's.



9. Adjust the output intensity by turning the knobs clockwise. The numeric display shows the output in the units indicated by the lit LED below the display for that channel. *Please note:* Adjust the intensity at the peak when the current is on with an amplitude modulation function. Adjust intensity down any time during the On time.
NOTE 1: For the surge mode, adjust the output intensity for the active channels and then press to start the Surge cycle. The timer will then begin counting.
NOTE 2: For the reciprocation mode adjust the intensity for Channel 1 and then press . Then adjust the intensity for Channel 2 and press .

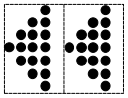
10. In the interferential mode, press the amplitude modulation (*vector rotation*) key after the output intensity is adjusted. Adjust intensity Up only at the peak and Down at any time.

11. Press the "Hold" key to temporarily suspend treatment. All treatment parameters except output intensity will be retained. Press to resume treatment and then readjust the output intensity.

12. At the end of a treatment the output intensity will return to zero, the treatment status indicator stops moving and the output displays show "- - - - - -". Remove the electrodes from the patient at this time.

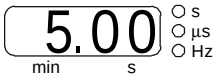
8.5 Ultrasound Set-up Procedure

1. Press the ultrasound treatment key. The treatment status indicator will display the ultrasound icon.

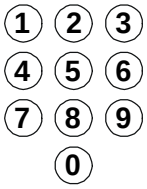


2. The green LED indicator will illuminate for the ultrasound treatment. Indicators will blink for channels that have already been programmed, but are not being programmed currently.

   To view the parameters for a channel, whose indicators are blinking, press the selector button. You will then be able to view selected treatment parameters, treatment output and time remaining or elapsed.



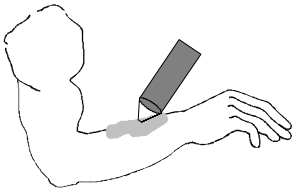
3. Input treatment time. The maximum treatment time is 30 minutes. If you do not input time the timer will display elapsed time during the treatment and stop at 30 minutes.



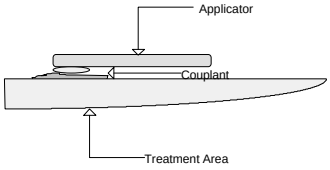
4. If you have the dual frequency 5 cm² applicator attached, press this key to select the output frequency. The 10 cm² applicator will light up the 1 MHz LED and the 1 cm² will light up the 3 MHz LED.

5. Press this key to select either Watts or Watts/cm² for the output display.

6. Select the duty cycle for the ultrasound from continuous (100%) or pulsed (50% or 20%).

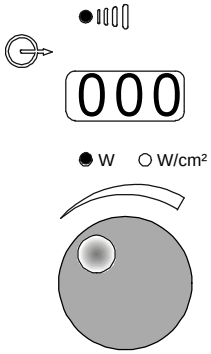


7. Apply a layer of Sonigel (ultrasound couplant gel or lotion) to the treatment area.



8. Couple the applicator to the treatment area by keeping the entire surface of the applicator in contact with the gel that has been applied to the patient. This will ensure efficient delivery of therapeutic ultrasound to the patient.

9. Press the start key to begin treatment.



10. Adjust the ultrasound power to the desired output intensity, by turning the control knob clockwise to increase intensity and counter-clockwise to decrease it. Remember to couple the applicator to the patient while adjusting ultrasound power. The amber LED marked for ultrasound will indicate that ultrasound is being generated.

11. If the applicator is not in contact with the patient or ultrasound is not being efficiently transmitted to the patient, the LED in the symbol pictured to the left will blink. If inadequate coupling occurs for more that 30 continuous seconds, *6 continuous seconds for CE model*, the Sonicator Plus 992 will automatically stop ultrasound output, beep twice and display "E002" in the time display.

12. If you need to temporarily stop treatment press the hold button pictured on the left. Remaining treatment time and selected output power are displayed, *power reset for CE models*. Ultrasound power will stop. To resume treatment, press ◈, *readjust output power for CE model.*

13. **Notes on coupling**: Failure to efficiently transmit therapeutic dosages of ultrasound to the patient can be caused by the following:

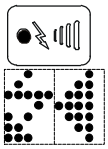
    a) Treatment of an irregular area where it is impossible to keep the applicator surface in contact with the gelled patient area. In this case you can try to use a little more gel or perform underwater treatment, if the treatment area is submersible in water.

    b) An inappropriate couplant is being used. Only materials that efficiently transmit ultrasound should be used for therapeutic ultrasound applications. Some creams and oil-based preparations are not efficient ultrasound couplants. If you use these materials the coupling indicator LED may blink and E002 may be displayed.

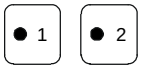
    c) Areas of heavy body hair will trap air beneath the hair and prevent ultrasound transmission. Shaving the treatment area prior to treatment or thoroughly wetting the area prior to the application of couplant will result in more efficient transmission of ultrasound.

14. When the set treatment time has elapsed, the unit beeps three times. Time and ultrasound power displays will display "0" and ultrasound power will turn off.

8.6 Combination Therapy Set-up Procedure



1. Press the combination treatment selector. The Treatment Status Indicator will show you the combination icon and the waveform LED's for Premodulation, Medium Frequency, Biphasic *(TNS)* and High Volt will begin to blink.



2. The green LED indicators will illuminate for the ultrasound treatment and Channel 1. Indicators will blink for channels that have already been programmed, but are not being currently displayed.

To view the parameters for a channel, whose indicators are blinking, press the selector button. You will then be able to view selected treatment parameters, treatment output and time remaining or elapsed.

3. Select the stimulation waveform that you would like to use.

Premodulated

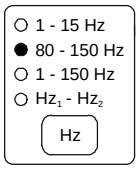
Medium Frequency, *Russian waveform*

Biphasic *(TNS)*

High Volt

Please Note: Combination therapy is available with Channel 1 only. The Treatment Status Indicator displays the icon for the selected waveform plus ultrasound.

4. Set treatment pulse frequency (*Hz*), phase duration (µs) and polarity (+ *or* -) for each waveform, if appropriate.

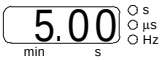


Premodulated—
Choose from preset frequency modulation programs: 1-15, 80-150 or 1-150 Hz or...
Pick Hz_1-Hz_2 to set your own static frequency or frequency sweep range. Enter values for each frequency using the numeric keypad followed by the ↵ key. The frequency is displayed in the timer window and the Hz LED is lit.

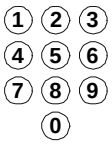
Medium Frequency—
No optional selections

Biphasic *(TNS)*—
The Sonicator Plus 992 stores the value for the phase duration and the frequency for the last Biphasic *(TNS)* session. If the value displayed in the timer window is acceptable press the ↵ key.
Set µs for the phase duration, 50-300 µs. Enter a numeric value followed by the ↵ key.
Set Hz for the frequency, 1-120 Hz. Enter a numeric value followed by the ↵ key.

High Volt—
Set the treatment polarity. The LED that is lit indicates the red lead wire's polarity.
Set Hz for the frequency, 1-120 Hz. Enter a numeric value followed by the ↵ key.



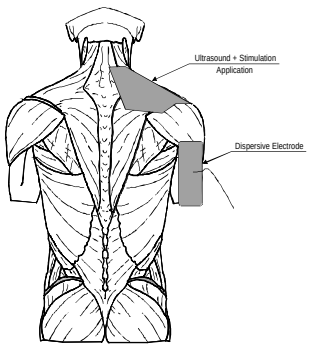
5. Input treatment time. The maximum treatment time is 30 minutes. If you do not input time the timer will display elapsed time during the treatment and stop at 30 minutes.



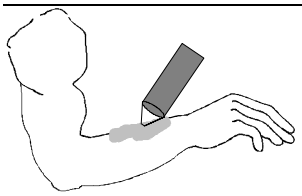
6. If you have the dual frequency 5 cm² applicator attached, press this key to select the output frequency. The 10 cm² applicator will light up the 1 MHz LED and the 1 cm² will light up the 3 MHz LED.

7. Press this key to select either Watts or Watts/cm² for the output display.

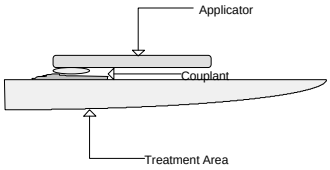
8. Select the duty cycle for the ultrasound from continuous (100%) or pulsed (50% or 20%).



9. Apply the dispersive electrode to the patient. Plug the single electrode cable (ME 2261) into channel one. Plug the electrode into the single electrode cable or the red end of a regular electrode cable (ME 2260). WARNING: Apply the dispersive electrode in such a manner to prevent transthoracic stimulation.

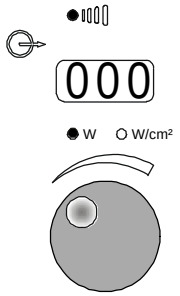


10. Apply a layer of Sonigel (ultrasound couplant gel) to the treatment area. *Please note: the couplant must also be electrically conductive for combination therapy*.

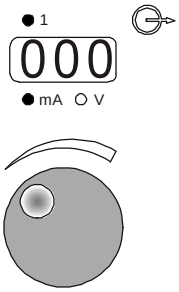


11. Couple the applicator to the treatment area by keeping the entire surface of the applicator in contact with the gel that has been applied to the patient. This will ensure an efficient delivery of therapeutic ultrasound to the patient.

12. Press the start key to begin treatment.



13. Adjust the ultrasound power to the desired output intensity, by turning the control knob clockwise to increase intensity and counter-clockwise to decrease it. Remember to couple the applicator to the patient while adjusting ultrasound power. The amber LED marked for ultrasound will indicate that ultrasound is being generated.



14. Adjust the stimulation output to the desired output intensity, by turning the control knob clockwise to increase intensity and counter-clockwise to decrease it.

15. If the applicator is not in contact with the patient or ultrasound is not being efficiently transmitted to the patient, the LED in the symbol pictured to the left will blink. If inadequate coupling occurs for more that 30 continuous seconds the Sonicator Plus 992 will automatically stop ultrasound output, beep twice and display “E .02” in the time display.

16. Press the “Hold” key to temporarily suspend treatment. All treatment parameters except stimulation output intensity will be retained. Press ◈ to resume treatment and then readjust the stimulation output intensity. *For CE model ultrasound power must also be readjusted.*

17. At the end of a treatment the output intensity will return to zero, the treatment status indicator stops moving and the output displays show “- - - 000“. Remove the electrodes from the patient at this time. Wipe any gel residue from the patient’s skin.

8.7 Electrode Positioning

1. General information

Placement of electrodes may be by the quadpolar, bipolar or monopolar techniques. Proper positioning and contact will insure treatment comfort and efficiency. Electrodes should never be placed in such a manner as to produce current flow through the cardiac area. For safe operation of the Sonicator Plus 992, review contraindications, warnings, precautions and Side Effects/Adverse Reactions in sections 5.4, 5.5, 5.7 and 5.8 before

positioning electrodes.

2. Preparation of the skin prior to electrode application

   To insure the efficient current conduction necessary for proper treatment, certain preparations must be made. Cleaning or wetting should eliminate any impairment to current conduction on the patient's skin such as an oily or dry surface, or excessive hair coverage. Shaving may be necessary depending upon the density of hair coverage. **Failure to provide for maximum current conduction efficiency could result in skin irritation relating to an increase in current density at the electrode site.**

   Using reusable electrodes for longer periods of time than those recommended by the package insert could result in ineffective treatments or cause skin irritation. Care should be taken to ensure application of the total electrode surface area to the patient's skin prior to commencing treatment.

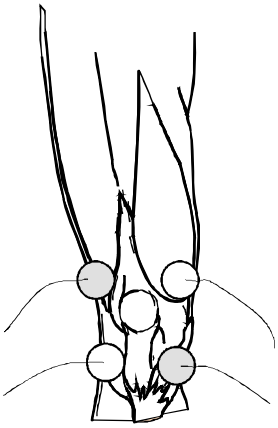


Figure 8.3—Quadpolar Electrode Placement Technique

3. Quadpolar electrode application technique

   Quadpolar techniques should be used with the "Interferential" waveform. The electrodes from Channel 1 are placed diagonally from each other. While the electrodes from Channel 2 are placed diagonally across from each other to form an "X" over the treatment area. The zone of maximum interference between the two channels occurs roughly in the center of the "X".

   Constantly changing the intensity levels of the two channels will change the interference pattern felt by the patient. Pressing the amplitude modulation key will constantly change the intensity of the outputs of the two channels during treatment, increasing the area covered by the interference pattern.

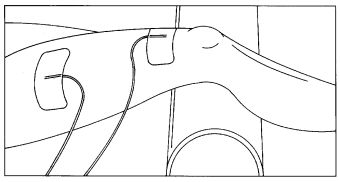


Figure 8.4—Bipolar Electrode Placement Technique

4. Bipolar electrode placement techniques

   Bipolar electrode placement techniques should be used to provide stimulation to larger muscle groups, such as the quadriceps or the hamstrings. The symmetrical waveforms of the "Premodulated", "Medium Frequency" and "Biphasic" waveforms are usually applied to the body using the bipolar technique.

   Equal size electrodes are placed at each end of the muscle or muscle group. Current concentration is over the entire length of that muscle or muscle group and especially effective on weak musculature. Electrode placement should be at opposite ends of the limb or muscle group. Care should be taken to insure that electrodes are not placed too close together which could produce current concentration along the edges of the pads. This is the so-called "edging effect" which can cause patient discomfort. The figure on the left shows a pad set up for stimulation of the quadriceps.

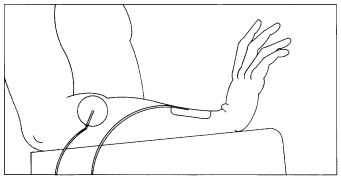


Figure 8.5—Monopolar Electrode Placement

5. Monopolar electrode application techniques

   Monopolar techniques may be used with the "High Volt", "Microcurrent", "Premodulated", "Medium Frequency" and *(TNS)*" waveforms. The smaller, active, electrode (black and negative) is placed over the muscle motor point. In treatments designed to relieve pain, the active electrode is placed over the painful area. The larger, dispersive, electrode (red and positive) is placed on the same side of the body at some point

Technique

distal to the active electrode. The dispersive pad is generally three to four times larger than the active electrode so that current density is too low to cause muscle contractions under the dispersive electrode. Never place the dispersive electrode over the antagonist muscle.

The monopolar electrode placement technique has been found to be especially useful for muscle stimulation of the upper extremities and small muscle groups. This technique helps concentrate the stimulation effect on the muscle under the smaller electrode. The figure on the left illustrates one possible electrode placement for muscle stimulation of the forearm.

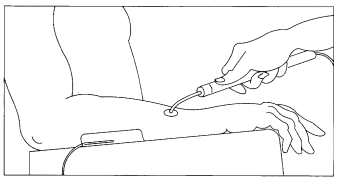


Figure 8.6—Using the Pencil Electrode

6. Using the pencil electrode, *Domestic model only*

   The pencil electrode is used for the stimulation of small muscles or painful areas. It is also useful to help identify the exact motor point of a muscle or muscle group. The pencil electrode may be used with the "Premodulated", "Medium Frequency" or "Biphasic *(TNS)*" waveforms.

   Attach the pencil electrode to the black electrode cable using a pin to banana adapter. Attach the red electrode cable to a dispersive pad. Apply dispersive electrode in such a manner to prevent transthoracic stimulation

   Pressing the switch located on the pencil electrode will allow treatment currents to be delivered to the patient. Four tips of different sizes are included with the pencil electrode. The figure on the left shows an application of the pencil electrode.

7. Additional information about electrode placement:

   Motor point charts are available as guides from Mettler Electronics Corp. These points may vary from patient to patient, and at time of injury, may vary in the same patient. "Functional Electrical Stimulation - A Practical Clinical Guide" by Benton, Baker, Bowman and Walters: published by Rancho Los Amigos of Downey, California is an excellent guide for electrode placement for muscle stimulation. "Clinical Transcutaneous Electrical Nerve Stimulation" by Mannheimer and Lampe is a good source for electrode placement techniques for pain management.

Section 9—Maintenance and Troubleshooting

9.1 Cleaning the Sonicator Plus 992

1. The Sonicator Plus 992 can be wiped off with a damp cloth. The power cord should be disconnected from the unit before this is done. In the case of stubborn dirt a gentle household cleaner can be sprayed on the cloth and then wiped on the unit. If this method is used, remove any cleaner residue with a damp cloth. Do not spray cleaner into the vents of the unit.
2. Follow the EZ Trode package insert for the use and care of the electrodes supplied with the Sonicator Plus 992.
3. For routine cleaning of the electrode cables use soap and water. Thoroughly dry after cleaning.
4. Use soap and water for routine cleaning of the Sonicator Plus 992 applicators. When disinfection is necessary, use a disinfectant such as a 10% bleach solution. Rinse the applicator thoroughly after disinfection to remove any residue. The Sonicator Plus 992 applicator *is neither autoclavable nor* gas sterilizable.

9.2 Routine Maintenance

1. Standard medical electrical safety checks should be performed annually by qualified biomedical engineers or technicians trained to perform these procedures.
2. Inspect electrode cables and associated connectors for damage.
3. To assure accurate performance of the Sonicator Plus 992, calibration verification of ultrasonic output should be performed on an annual basis.
4. Inspect treatment head for cracks, since they may allow ingress of conductive fluid(s).
5. Inspect treatment head cables and associated connectors for damage.
6. Avoid rough handling of the treatment head, since it is critical to the safe and effective application of therapeutic ultrasound and relatively fragile.

9.3 Troubleshooting the Sonicator Plus 992

Symptom	Action
1. Nothing lights when main power switch is turned on.	Is line cord connected to outlet? Does the outlet have power? Unit may require servicing if none of the above resolve the problem. Open unit and check fuses on power supply board. If these are OK, replace power supply.
2. "E001" displayed in Time window.	Check applicator cable connections to make sure they are securely attached to the Sonicator Plus 992 and the applicator and the rings are turned fully clockwise to lock connectors. Replace applicator cable. Replace applicator.

3. “E002” displayed in Time window.	There is insufficient ultrasound coupling. Use gel or lotion labeled for therapeutic ultrasound coupling. Resume treatment after applying proper couplant.
	Replace applicator.
4. “E003” displayed in Time window.	The Sonicator Plus 992 cannot tune to the applicator transducer. Turn unit off and then on and try to begin another ultrasound treatment. If the error code persists, the applicator and/or the Sonicator Plus 992 require servicing.
	Replace cable.
	Replace applicator.
5. “E004” displayed in Time window.	There is a malfunction in the power output circuitry for ultrasound. Turn unit off and then on and try to begin another ultrasound treatment. If the error code persists, the Sonicator Plus 992 requires servicing.
	Replace main board.
6. “E005” displayed in Time window.	There is a malfunction in the power output circuitry for ultrasound. Turn unit off and then on and try to begin another ultrasound treatment. If the error code persists, the Sonicator Plus 992 requires servicing.
	Replace main board.
7. “E60 _” displayed in Time window.	There is an output voltage error for electrical stimulation. If powering unit OFF and restarting does not remove error, the unit requires servicing.
	Replace electrode cables.
	Replace main board.
8. “E70_” displayed in Time window.	If E7 occurs during the treatment the patient connection impedance may be increasing because the electrodes are drying out or lifting from the patient.
	If E7 occurs when the output is first being adjusted, it may mean the electrodes or cables are not making a good circuit. Check cable and electrode connections and make sure electrodes are making good contact with the patient.
	In the continuous treatment modes the output voltage is reduced while the unit monitors the impedance of the patient connection. If the unit is in amplitude modulated modes, such as recip or surge, this patient connection error causes the unit to go into the HOLD mode.
	All patient connection errors should be investigated to determine their cause.

9. "E80_" displayed in Time window.	An output overcurrent has been detected. Current exceeded 70 mA RMS for interferential, 55 mA for premodulated, and medium frequency or 105 mA peak for biphasic *(TNS)*.
	Reposition electrodes farther apart. Remove any moisture or gel from between the electrodes and try again. If error persists even without a patient connection or load, unit requires servicing.
	Replace main board.
10. "E90_" displayed in Time window.	Output error for electrical stimulation has been detected. Remove electrode cables from unit and restart. Replace electrode cables onto unit. Reprogram treatment and try starting treatment session again.
	If powering unit OFF and restarting does not remove error, the unit requires servicing.
	Replace electrode cables.
	Replace main board.
11. "F1 _" displayed in Time window.	There has been a communication error between the microprocessors. If powering unit OFF and restarting does not remove error, unit requires servicing.
	Replace main board.
12. "F2 _" displayed in Time window.	There has been a self-test fail error— If powering unit OFF and restarting with all the electrode cables removed does not remove error, the unit requires servicing.
	Replace main board.
13. "F3 _" displayed in Time window.	There has been a power supply voltage error— If powering unit OFF and restarting does not remove error, the unit requires servicing.
	Replace power supply.

If problem is not addressed above, or if additional troubleshooting guidance is desired, call (800) 854-9305 or 1-714-533-2221 (*outside the USA*).

The distributor who sold the Sonicator Plus 992 should be able to assist you with a loaner unit during warranty service.

Section 10—
Test and Calibration Procedure

The following procedure is used to verify that all functions of the Sonicator Plus 992 are performing to product specifications. This procedure should be performed whenever a main board is replaced or when there is any question about the performance of the unit.

10.1 Required Equipment

Measurement Equipment Required:

Digital Volt Meter
100MHz Dual Channel Oscilloscope
(2) 10x probe
(1) 100x probe
Frequency Counter
Ultrasound Power Meter
(2) True RMS Digital Ammeters
Leakage Current Tester
Hipot Tester

Other Equipment Required:

115 VAC ± 10% Variac (variable voltage transformer)
230 VAC ± 10% Variac
BNC "T" connector
(2) 1 K Load Resistors, 20 W.

Before Testing Units:

Review Safety Instructions in User Manual
Review Operating Instructions in User Manual
Review Keyboard Symbol Definitions in User Manual

10.2 Preliminary Tests

1. Visual Check

Check unit for proper construction. Open unit case. Check primary wiring and fuses. Verify that fuses are 4 amp, slo-blo (type T).

2. Power Supply Test

Disconnect the power supply cable from the power supply. Connect the unit to a Variac. Adjust the Variac for 115 VAC out. (230 VAC for IEC). Turn power on. Check for proper power supply voltages at the power supply.

Description	Location (J4)	Limits
+5v	1	4.9 to 5.1 vdc
Common	2	---
Power Fail	3	7.5 to 8.5 vdc
+18v	4	17.4 to 18.6 vdc
Common	5	---
Common	6	---
-18v	7	-17.4 to -18.6 vdc
Blank	8	---
Common (2)	9	---
Blank	10	---
+38v (2)	11	34.9 to 41.1 vdc

Turn power off. Reconnect the power supply cable to the power supply.

3. Main Bd: Power Up Check

Turn power on.
The timer display should show "----". The output displays should show "---". The 3 treatment LED's should flash.

10.3 Diagnostic Tests

1. Enter Diagnostic Mode

Press the Continuous key and turn power on. The timer display will show dd00.

To start a diagnostic press its number and then the Go key.
To exit a diagnostic press the Stop All key.

2. Review Software Revision Diagnostic

Diagnostic 2: This diagnostic displays the last Configuration Code that was entered.

Press the 2 key and then the Go key.
Note the software revision indicated. This may be required for any replacement from the factory.
Press the Stop All key to exit.

3. Keyboard Diagnostic

Diagnostic 3: This diagnostic checks the function of all the keys on the keyboard.

Press the 3 key and then the Go key to start the Key Board Diagnostic.

Press each key. The beeper beeps and the key code is displayed in the timer window. See Appendix C for the list of key codes. Test all keys.

Turn the output knobs to verify that the encoders are working. Turning CW counts up from zero in the output windows. Turning CCW counts down to zero in the output windows. Each detent should change the number one count.

Press the Stop All key to exit.

4. Display Diagnostic

Diagnostic 4: This diagnostic tests the function of all the seven-segment, dot matrix, and discrete LED's.

Press the 4 key and then the Go key to start the Display Diagnostic.

The 10 seven segment LED's will count continually from 0-9, A-F. Verify that all the 7 segment LED's are the same color and intensity, and are lined up evenly.

An "X" will be scrolling left to right on the graphic display. Verify that all the dots light, and are the same color and intensity.

All of the discrete LED's will also be on, either flashing, or on solid. Verify that they are centered in the openings. Adjust individual LED's as needed.

Verify that the discrete LED's are lined up with the front panel. When completed install the membrane switch on front housing in the proper location.

Press the Stop All key to exit.

5. Ultrasound VCO Calibration

Diagnostic 7: This diagnostic programs the EEPROM in the HC11F1 (U4) with the proper DAC values for the end frequencies of the three VCO sweeps. 1&2 program the 1.0 MHz sweep, 2&3 program the 3.2MHz sweep, and 5&6 program the 3.3 MHz sweep. The frequencies are monitored at TP1 on the Main Bd, which gives a frequency that is 6 times the output frequency. All adjustments are ±0.01 MHz.

Press the 1 key. Monitor the low end of the 1 MHz VCO sweep frequency at TP1 on the Main Bd. Adjust it to 5.580 MHz by turning the Channel 1 output knob on the front panel. The DAC value will be shown in the Channel 1 output window. When adjusted, press the Go key to save the DAC value. Record the DAC value.

Press the 2 key. Monitor the high end of the 1 MHz VCO sweep frequency at TP1 on the Main Bd. Adjust it to 6.420 MHz by turning the Channel 1 output knob on the front panel. The DAC value will be shown in the Channel 1 output window. When adjusted, press the Go key to save the DAC value. Record the DAC value.

Press the 3 key. Monitor the low end of the 3.2 MHz VCO sweep frequency at TP1 on the Main Bd. Adjust it to 5.960 MHz by turning the Channel 1 output knob on the front panel. The DAC value will be shown in the Channel 1 output window. When adjusted, press the Go key to save the DAC value. Record the DAC value.

Press the 4 key. Monitor the high end of the 3.2 MHz VCO sweep frequency at TP1 on the Main Bd. Adjust it to 6.840 MHz by turning the Channel 1 output knob on the front panel. The DAC value will be shown in the Channel 1 output window. When adjusted, press the Go key to save the DAC value. Record the DAC value.

Press the 5 key. Monitor the low end of the 3.3 MHz VCO sweep frequency at TP1 on the Main Bd. Adjust it to 6.140 MHz by turning the Channel 1 output knob on the front panel. The DAC value will be shown in the Channel 1 output window. When adjusted, press the Go key to save the DAC value. Record the DAC value.

Press the 6 key. Monitor the high end of the 3.3 MHz VCO sweep frequency at TP1 on the Main Bd. Adjust it to 7.060 MHz by turning the Channel 1 output knob on the front panel. The DAC value will be shown in the Channel 1 output window. When adjusted, press the Go key to save the DAC value. Record the DAC value.

Press the Stop All key to exit the VCO Diagnostic.

6. Generate Variable Supply Lookup Table

Diagnostic 8: The 0-38 volt variable supply is controlled with an 8 bit DAC value sent from the HC11F1 (U4). This diagnostic generates the DAC value lookup table that contains the DAC value for every output voltage.

Press the 8 key and then the Go key.

The unit will cycle from 00 through FF, determine the proper value for each output voltage using the ADC, and record the values in the EEPROM in the HC11F1.

The unit will then measure the voltage produced by each value and report the step with the biggest error. The first 2 digits in the timer window are the step and the last 2 are the error. Verify that the error is less than 05.

The diagnostic may be repeated several times if necessary to get passing results.
Press the Stop All key to exit the Diagnostic.

7. Program Default Values

Diagnostic 9: This diagnostic resets all treatment options to default settings. Each channel has its own defaults. This diagnostic is used after testing is complete to restore all the treatment option settings to default values.

Treatment Option	Default
Interferential Sweep Low	1
Interferential Sweep High	15
Premodulated Sweep Low	1
Premodulated Sweep High	15
Biphasic *(TNS)* Pulse Width	300
Biphasic *(TNS)* Frequency	120
High Volt Frequency	120
Micro Current Frequency	100
Reciprocate Time	10
Surge On Time	10
Surge Off Time	10
Ultrasound Units	W

Press the 9 and then the Go key.
The diagnostic exits automatically.

8. Exit Diagnostic Mode
Turn power off, and then back on.

10.4 Ultrasound Output Tests

1. Output Waveforms
Connect a 10x1 applicator to the unit with a BNC "T" connector. Connect a 10x-scope probe to the BNC connector. Place the applicator in the ultrasound wattmeter. Zero the wattmeter. Put 5 minutes on TIME. Press Go. Turn the output knob until 2 watts is indicated. Verify that the output waveform is a smooth sinewave. Verify that the proper ultrasound LED's are lit. Repeat with the other applicators.

2. Output Power
Test each applicator as specified below. Verify that the proper frequency and power ranges are selected for each applicator. Verify that the output power is within the allowable range. Record the results:

10 cm² x 1 MHz

Watts Indicated	Watts Measured
5.0	4.25 - 5.75
10.0	8.5 - 11.5
20.0	17.0 - 23.0
22.0	18.7 - 25.3

5 cm² x 1 MHz

Watts Indicated	Watts Measured
2.0	1.70 - 2.30
5.0	4.25 - 5.75
10.0	8.5 - 11.5
11.0	9.35 - 12.65

5 cm² x 3 MHz

Watts Indicated	Watts Measured
2.0	1.7 - 2.3
5.0	4.25 - 5.75
10.0	8.5 - 11.5
11.0	9.35 - 12.65

1 cm² x 3 MHz

Watts Indicated	Watts Measured
0.5	.42 - .58
1.0	.85 - 1.15
2.0	1.70 - 2.30
2.2	1.87 - 2.53

3. Pulse Test
Connect a 10x1 applicator to the unit:

Press Go. Increase power to 5 W.

Press the ultrasound frequency key to select a 50% duty cycle.
The 50% led should light.

Verify the output waveform is 5 ms on and 5 ms off. (20% tolerance)
Press the ultrasound frequency key to select a 20% duty cycle.
The 20% led should light.

Verify output waveform is 2 ms on and 8 ms off. (20% tolerance)
Press the ultrasound frequency key. The 100% LED should light and the output should return to 100%.

Press Hold.

10.5 Ultrasound Error Tests

1. Error 1: No Applicator Connected

Press Go. Disconnect the 10x1 applicator from the unit.
The unit should beep twice, stop the treatment, and display E001.
Reconnect the applicator. Treatment time remaining should be displayed.
Repeat the test with the other 3 applicators.

2. Error 2: Bad Ultrasound Contact

Connect a 10x1 applicator to the unit.
Put the applicator in the water. Press the Go key.
Remove the applicator from the water.
The ultrasound power LED should begin blinking. After 30 seconds, (6 seconds for IEC units), the unit should beep twice, stop the treatment, and display E002.
Repeat the test with the other 3 applicators.

3. Error 3: Bad Crystal Tuning

Remove the crystal from a 10x1 applicator.
Connect the applicator to the unit.
Press the Go key.
Within 5 sec., the unit should beep twice, stop the treatment, and display E003.

4. Error 4: Output Stage Short Circuit

Reassemble the 10x1 applicator and connect it to the unit.
Place the applicator in water. Press the Go key.
Increase power to 5 W.
On the Main Bd, jumper R32/R33 junction to +5v
The unit should beep twice, stop the treatment, and display E004.

5. Error 5: US Output Out of Calibration

Make sure the 10x1 applicator is connected to the unit and in water.
Press the Go key. Increase power to 5 W.
On the Main Bd, jumper a 10 K resistor across R32.
The unit should beep twice, stop the treatment, and display E005.

10.6 Stimulation Treatment Mode Output Tests

1. Interferential Output Tests:

Start an Interferential treatment on Channels 1 and 2. 1-15 Hz sweep. Install a 1 Kohm load on each output in series with an ammeter. Connect a scope probe across each load resistor. Adjust R84 (Channel 1) and R102 (Channel 2) fully clockwise.

Start the treatment. Adjust the outputs until the ammeters both read 30 ma. Adjust R84 and R102 CCW until the output displays read the same as the ammeters. If during the adjustment the display goes below 30 ma, then turn the pot fully clockwise again, and restart the treatment.

Verify each channel's output is a smooth sinewave.
Measure the frequency of Channel 1. Record the frequency. s/b 4000 ± 3 Hz
Measure the sweep frequency of Channel 2. Record the low and high sweep frequencies. s/b 1 to 15 Hz. ±2 Hz

Verify the sweep time. s/b 14 ± 1 sec

Stop the treatment. Set 4000 Hz on Channel 2. Restart the treatment and adjust to 20 ma. Record the frequency of Channel 2. s/b 4000 ± 3 Hz

Stop the treatment. Set 4001 Hz on Channel 2. Restart the treatment. Adjust to 20 ma. Record the frequency. s/b 4001 ± 3 Hz
Stop the treatment. Set 4100 Hz on Channel 2. Restart the treatment. Adjust to 20 ma. Record the frequency. s/b 4098 ± 3 Hz

Stop the treatment. Set 4250 Hz on Channel 2. Restart the treatment. Adjust to 20 ma. Record the frequency. s/b 4243 ± 3 Hz

Stop the treatment. Set Channel 2 to sweep from 1 to 150 Hz. Restart the treatment. Record the actual current at 0 ma displayed on both channels. s/b 0 ± 1 ma

Adjust the displayed current to 10 ma. Record the actual current of both channels. s/b 10 ± 2 ma

Adjust the displayed cur rent to 20 ma. Record the actual current of both channels. s/b 20 ± 4 ma

Adjust the displayed current to 30 ma. Record the actual current of both channels. s/b 30 ± 6 ma

Adjust the displayed current to 40 ma. Record the actual current of both channels. s/b 40 ± 8 ma

Adjust the displayed current to 50 ma. Record the actual current of both channels. s/b 50 ± 10 ma

Adjust the displayed current at 60 ma. Record the actual current of both channels. s/b 60 ± 12 ma

Stop the treatment.

Restart the treatment.

Adjust for 40 ma on both channels. Press rotate.
Verify that the output displays alternately decrease to 18-22 ma and, and that the measured currents vary appropriately.

Verify that the cycle time is 8 ± 1 sec.
Stop the treatment.

2. Premodulated Output Tests:

NOTE: Use the Premodulated Sync Test Fixture (Dwg 19111) as required to obtain the sweep frequency measurements. Attach V_{in} connections across output load. Attach F_{out} connections to frequency counter.

Put the unit in Premodulated mode. 1-15 Hz sweep.
Start the treatment. Adjust the outputs to 20 ma.
Verify that the modulation is sweeping from 1 to 15 Hz.
Verify the sweep time. s/b 14 ± 1 sec
Stop the treatment. Set the modulation frequency to 1 Hz. Restart the treatment. Adjust to 20 mA. Record the base frequency. s/b 4000 ± 3 Hz
Record the modulation frequency. s/b 1 ± 0.5 Hz

Stop the treatment. Set the modulation frequency to 100 Hz. Restart the treatment. Adjust to 20 mA. Record the modulation frequency. s/b 98 ± 3 Hz

Stop the treatment. Set the modulation frequency to 250 Hz. Restart the treatment. Adjust to 20 ma. Record the modulation frequency. s/b 243 ± 3 Hz

Stop the treatment. Set the sweep to 80 to 150 Hz. Restart the treatment. Record the currents at 0 mA displayed on both channels. s/b 0 ± 1 ma

Adjust the displayed current to 10 ma. Record the actual current of both channels. s/b 10 ± 2 ma

Adjust the displayed current to 20 ma. Record the actual current of both channels. s/b 20 ± 4 ma

Adjust the displayed current to 30 ma. Record the actual current of both channels. s/b 30 ± 6 ma

Adjust the displayed current to 40 ma. Record the actual current of both channels. s/b 40 ± 8 ma

Adjust the displayed current to 50 ma. Record the actual current of both channels.
s/b 50 ± 10 ma

Stop the treatment.

3. Medium Frequency Output Tests:

Put the unit in Medium Frequency Mode. Start the treatment.
Adjust the outputs to 20 ma.
Verify smooth sine waves with 50% duty cycle.
Record the frequency s/b 2500 ± 3 Hz

Verify that the On and Off times are each 10 ± .5 ms.
Stop the treatment.

Restart the treatment. Record the actual currents at 0 ma displayed on both channels.
s/b 0 ± 1 ma

Adjust the displayed current to 10 ma. Record the actual current of both channels.
s/b 10 ± 2 ma

Adjust the displayed current to 20 ma. Record the actual current of both channels.
s/b 20 ± 4 ma

Adjust the displayed current to 30 ma. Record the actual current of both channels.
s/b 30 ± 6 ma

Adjust the displayed current to 40 ma. Record the actual current of both channels.
s/b 40 ± 8 ma

Adjust the displayed current to 50 ma. Record the actual current of both channels.
s/b 50 ± 10 ma

Stop the treatment.

4. Biphasic *(TNS)* Output Tests:

Put the unit in Biphasic *(TNS)* mode. 150 usec, 120 Hz. Start the treatment. Adjust the outputs to 20 ma.
Verify outputs are biphasic square waves.
Record the positive pulse width. s/b 150 ± 15 us
Record the pulse frequencies are 120 ± 1 Hz.
Stop the treatment.

Restart the treatment. Record the positive and negative pulse voltages at 0ma displayed.
s/b 0 ± 1 volts

Adjust the displayed current to 10 ma. Record the positive and negative pulse voltages of both channels. s/b 10 ± 2 volts

Adjust the displayed current to 20 ma. Record the positive and negative voltages of both channels. s/b 20 ± 4 volts

Adjust the displayed current to 30 ma. Record the positive and negative voltages of both channels. s/b 30 ± 6 volts

Adjust the displayed current to 40 ma. Record the positive and negative voltages of both channels. s/b 40 ± 8 volts

Adjust the displayed current to 50 ma. Record the positive and negative voltages of both channels. s/b 50 ± 10 volts

Adjust the displayed current to 60 ma. Record the positive and negative voltages of both channels. s/b 60 ± 12 volts

Adjust the displayed current to 70 ma. Record the positive and negative voltages of both channels. s/b 70 ± 14 volts

Adjust the displayed current to 80 ma. Record the positive and negative voltages of both channels. s/b 80 ± 16 volts

Adjust the displayed current to 90 ma. Record the positive and negative voltages of both channels. s/b 90 ± 18 volts

Adjust the displayed current to 99 ma. Record the positive and negative voltages of both channels. s/b 99 ± 20 volts

Stop the treatment.

5. High Volt Output Tests:

Put the unit in High Volt mode on Channel 1, 120 Hz, positive polarity.
With no load connected to Channel 1, start the treatment.

Check no contact at 99 volts.

Connect a 1 K load to Channel 1, verify contact occurs.

Verify two exponentially decaying pulses with 50-100 us separation, 120Hz +/-1 Hz.

Verify polarity switches when polarity key is pressed. Return to positive polarity.

Adjust the displayed voltage to 101 v. Record the actual voltage s/b 101 ± 20 Vpk

Adjust the displayed voltage to 200 v. Record the actual voltage s/b 200 ± 40 Vpk

Adjust the displayed voltage to 300 v. Record the actual voltage s/b 300 ± 60 Vpk

Adjust the displayed voltage to 400 v. Record the actual voltage s/b 400 ± 80 Vpk

Adjust the displayed voltage to 500 v. Record the actual voltage s/b 500 ± 100 Vpk

Stop the treatment.

6. Micro Current Output Tests:

Put the unit in Micro Current mode, 500 Hz, bipolar polarity.

With no load connected press the Go key, verify that the unit beeps twice and E706 is displayed.

Connect a 1 K load, press the Go key and adjust output for 200 uv.

Verify a square wave signal with 500 Hz +/-50 Hz.

Adjust the displayed current to 50 ua. Record the measured voltage s/b 50 ± 10 mv.

Adjust the displayed current to 100 ua. Record the measured voltage s/b 100 ± 20 mv.

Adjust the displayed current to 200 ua. Record the measured voltage s/b 200 ± 40 mv.

Adjust the displayed current to 300 ua. Record the measured voltage s/b 300 ± 60 mv.

Adjust the displayed current to 400 ua. Record the measured voltage s/b 400 ± 80 mv.

Adjust the displayed current to 500 ua. Record the measured voltage s/b 500 ± 100 mv.

Adjust the displayed current to 600 ua. Record the measured voltage s/b 600 ± 120 mv.

Adjust the displayed current to 700 ua. Record the measured voltage s/b 700 ± 140 mv.

Adjust the displayed current to 800 ua. Record the measured voltage s/b 800 ± 160 mv.

Adjust the displayed current to 900 ua. Record the measured voltage s/b 900 ± 180 mv.

Adjust the displayed current to 990 ua. Record the measured voltage s/b 990 ± 198 mv.

10.7 Stimulation Recip and Surge Tests

1. Surge Tests—Single Timer:

Put Channel 1 & 2 in Premodulated mode, 1-15 Hz sweep.
Put Channel 1 & 2 in Surge, 2 sec on, and 3 sec off.
Start the treatment. Adjust both channels for 20 ma.
Verify that the up ramps are 3 sec, and the down ramps are 2 sec.
Verify that the channels are on together for 2 sec and off for 3 sec.

Stop the treatment.

2. Reciprocate Tests—Single Timer:

Put Channel 3 & 4 in Medium Frequency mode.
Put Channel 3 & 4 in Recip, 3 sec on and off.
Start the treatment. Adjust both channels to 20 ma.
Verify that the up and down ramps are 1 sec.
Verify that each channel is alternately on and off for 3 sec.

Stop the treatment.

3. Reciprocating Surge Tests—Single Timer:

Put Channel 1 & 2 in Biphasic *(TNS)* mode, 100 us, 120 Hz
Put Channel 1 & 2 in Surge, 5 sec on, and 15 sec off.
Press the Reciprocate button.
The Surge and Recip LED's should both be on.
Start the treatment. Adjust both channels for 20 ma.
Verify that each channel's up ramp is 3 sec, and down ramp is 2 sec.
Verify that the Channel 1 is on first for 5 sec, and then Channel 2 is on for 5 sec, and then both channels are off together for 5 sec.

Stop the Treatment.

10.8 Stimulation Error Tests

1. Error 6—Over Voltage Error

Install 1 Kohm loads in all channels.

Put the unit in Interferential mode. 1-15 Hz.

Start the treatment. Adjust Channel 1 for 20 ma.

Short TP10 to TP1. The unit should trip off and display E 06.

Cycle the power to reset the unit.

Put the unit in Premodulated mode: 80-150 Hz.

Start the treatment. Adjust Channel 2 for 20 ma.

Short TP13 to TP1. The unit should trip off and display E 06.

Cycle the power to reset the unit.

2. Error 7—No Contact Error

Remove the 1 K loads from both channels.
Put the unit in interferential mode, 1-15 Hz.
Start the treatment.
Try to adjust Channel 1 to 20 ma. Verify that E 07 occurs. Unit beeps twice, LED blinks.

Install the load in Channel 1. Verify E 07 clears.
Try to adjust Channel 2 to 20 ma. Verify that E 07 occurs.

Install the load in Channel 2. Verify E 07 clears.
Adjust outputs for 20 ma.
Remove the load from Channel 1. Verify E 07 occurs.
Replace the load in Channel 1. Verify E 07 clears.

Remove the load from Channel 2. Verify E 07 occurs.

Replace the load in Channel 2. Verify E 07 clears.

Repeat steps above in Biphasic *(TNS)* mode, 150 us, 80 Hz.

3. Error 8—Over Current Error

Put the unit in Medium Frequency mode.

Start the treatment. Adjust Channel 1 for 20 ma.

Short the output resistor. The unit should trip off and display E 08.

Cycle the power to reset the unit.

Put the unit in Biphasic *(TNS)* mode, 100 us, 100 Hz.

Start the treatment. Adjust Channel 2 for 40 ma.

Short the output resistor. The unit should trip off and display E 08.

Cycle the power to reset the unit.

10.9 EEProm Memory Test

Setup an Interferential treatment on Channels 1&2.
Setup a custom sweep for 11-22 Hz.
Turn power off for 5 sec.
Turn power back on.
Verify that the Channel 1&2 Interferential sweep setting is 11-22 Hz.

10.10 Combination Output Tests

Combination Output Tests:
Press the Combination Treatment key.
Press Medium Frequency.
Attach the 10x1 applicator to the unit. Place the applicator in the power meter.
Attach the Combination Patient Cable to Channel 1.
Connect a 1 K load resistor between the electrode cable and the water that the applicator is in. Connect a scope probe across the load.
Start the treatment. Increase the stimulation output to 20 ma, and the ultrasound output to 10 watts.

Verify the proper stimulation waveform. Verify the proper ultrasound power.
Disconnect the load at one end. Verify that the “no contact” error does not occur.
Reconnect the load. Verify the stimulation waveform.

Stop the treatment.

10.11 Input Current Test

Input Current Test
Connect the unit to a Variac.
Connect an ammeter in series with the power cord.
Adjust the voltage out of the Variac to 90VAC.
Install a 1 K load in series with an ammeter on each output.
Start an Interferential treatment on Channels 1 and 2, 1-15 Hz sweep.
Increase the current to 65 ma on both channels.
Connect the 10x1 applicator to the unit. Place the applicator in the power meter.
Start an ultrasound treatment. Increase the output power to 22 watts.
Verify that the stimulation currents are 65±13 ma.
Verify that the ultrasound power is 22±3.3 W.
Measure and record the line current. Verify that it is less than 2.0 amps.

10.12 Burn-In

This procedure is performed after replacing any chassis component or circuit board.

Turn power off. Seal the three pots. Complete final assembly.
Install 1 K loads on both channels.
Connect the 10x1 applicator.
Setup Channels 1&2 for Interferential, 1-15 Hz sweep.
Press the Go key and adjust to 65 ma on both channels.
Setup an ultrasound treatment.
Press the Go key and adjust the ultrasound to 22 W.
Run the treatments for 30 minutes.
Connect the 5xDual applicator.
Setup Channel 1 for High Volts, 120 Hz.
Press the Go key and adjust to 300 volts.
Setup Channel 2 for Micro Current, biphasic, 500 Hz.
Press the Go key and adjust to 990 ua.
Setup an ultrasound treatment.
Set for 3 MHz.
Press the Go key and adjust to 11 W.
Run the treatments for 30 minutes.

10.13 Final Adjustment

Enter diagnostic mode.
Press the 9 key and then the Go key to reset all the settings to their default values.

Turn off power.

Functional tests are complete.

10.14 Safety Tests

1. **Dielectric Withstand**
   Test the Dielectric Withstand from the blades on the power cord to the safety ground pin on the power cord. Test at 1500 VAC for 1 second with no breakdown. (A-a_1)
   Test the Dielectric Withstand from the blades on the power cord to each stimulation output connector. Test at 4000 VAC for 1 second with no breakdown. (B-a)
   Test the Dielectric Withstand from the blades on the power cord to the ultrasound connection. Test at 4000 VAC for 1 second with no breakdown. (B-a)
   Test the Dielectric Withstand from the ultrasound connection to each stimulation connection. Test at 1500 VAC for 1 second with no breakdown. (B-b)

2. **Leakage Current**
   Test Earth Leakage Current. Test at 264 VAC, 60 Hz. Test at max output of unit. Leakage current must be less than 500 ua in normal condition, and 1000 ua in single fault condition. Single fault conditions are: open neutral, reversed polarity, and open neutral with reversed polarity.
   Test Patient Leakage Current. Test at 264 VAC, 60 Hz Test at max output of unit. Leakage current must be less than 100 ua in normal condition, and 500 ua in single fault condition. Single fault conditions are: open neutral, reversed polarity, and open neutral with reversed polarity.

3. **Grounding Continuity**
   Test Grounding Continuity from the safety ground pin on the power plug to the chassis with a DVM. Must show continuity.

10.15 Final Operational Check

Connect unit to nominal power.
Connect 10x1 applicator.
Start US treatment
Verify output accuracy at 20 W.
Start Interferential treatment on Channels 1 & 2.
Verify output accuracy at 30 ma.

Section 11 — Parts Replacement

11.1 Chassis Disassembly

If an analysis of the error codes or the unit's operation suggests that it is necessary to replace an internal chassis component perform the procedures described below.

NOTE: IT IS IMPORTANT TO STRESS THAT ALL INTERNAL MECHANICAL AND ELECTRICAL COMPONENTS MUST BE REINSTALLED IN EXACTLY THE SAME MANNER AS ORIGINALLY ASSEMBLED. FAILURE TO OBSERVE THIS PRECAUTION WILL CAUSE THE UNIT TO FAIL HI POT TESTING WITH CONSEQUENT DAMAGE TO THE MAINBOARD ASSEMBLY. REPLACE ALL INTERNAL SHIELDS EXACTLY AS ORIGINALLY ASSEMBLED AND TAKE GREAT CARE NOT TO SCRATCH, PUNCTURE, OR ABRADE THE INSULATION COVERING SURFACES OF THESE SHIELDS.

Disconnect all power, electrode, and applicator cables from the chassis before proceeding.

11.2 Bottom Cover Removal

Place the unit face down on a clean protected surface taking care that the knobs are clear of the table surface by placing a support between the top of the chassis front and the table surface.

Remove the 14 Phillips head screws that hold the chassis bottom to the top.

Turn the unit over so that it is resting on its feet. Slowly lift the top straight up. When it is clear of the bottom rear flange, stop lifting and tilt the top to the left by raising the right side of the top until there is sufficient room to reach into the case and disconnect the ribbon cable from the power supply connector. The two unit halves may now be physically disconnected.

11.3 Chassis Bottom Components Servicing.

The components that may now be replaced are the cooling fan, power supply, fuses or power switch assembly

Cooling Fan Replacement

Unplug the fan power cable from the power supply. Loosen and remove the four bolts holding the fan to the chassis. Install the new fan. Tighten the four mounting bolts snug. Connect the power cable to the power supply.

Fuse Replacement

The line fuses are located at the right edge of the power supply circuit board near the line power inlet receptacle. With fingers or pliers pull the fuses from their clips and replace with fresh fuses.

Power Supply Circuit Board Replacement

Disconnect the fan power and inlet power connectors. Loosen and remove the four Phillips head screws in the corners of the circuit board. Squeeze first one and then the other plastic standoff head protruding through the circuit board at the board top and bottom center. Pull the power supply circuit board straight up and away from the chassis. Align the replacement power supply circuit board with the two plastic standoffs and press it down until the heads of the standoffs protrude through the circuit board. Replace and tighten the four Phillips head screws in the corners of the board. Connect the fan power and line power connectors to the circuit board connectors. Inspect the area under the circuit board to insure that there are no screws, washers, or other metal parts under the board that could pose a potential short circuit hazard.

Line Power Switch Replacement

Note the location and order of connection of the brown and blue wires connected to the power switch. There are two brown wires on the left side of the switch from top to bottom and there are two blue wires on the right side of the switch. Do not cross or switch their order when replacing them.

To remove the switch, firmly grasp each wire and pull it away from the switch until the connector slips off the switch terminal. Press the two plastic locking tabs together and pull the switch from the chassis.

Install the replacement switch in the same orientation as the switch that was removed and make sure that it is seated firmly in the chassis. Reconnect the two blue and brown wires exactly the way they were connected to the removed switch. Be careful not to push the switch back out from the chassis.

11.4 Chassis Top Components Servicing

The following components on the chassis top may now be replaced: The front panel membrane switch, the electrode connectors, the ultrasound output connector, and the main board assembly.

Replacing the Membrane Switch Panel

Place the chassis top face down on a clean surface and provide a support at the chassis top so that the front panel knobs are clear of the table surface. Remove the five Phillips head screws that hold the internal RF shield in place. CAREFULLY lift the shield away from the chassis so that it pivots up and away from the circuit board underneath. Observe that the ribbon cable for the membrane panel protrudes through the shield. With a small flat screw driver push the left and right retaining tabs on the ribbon cable connector on the main circuit board up until they click, indicating that the ribbon is now free. Pull the ribbon cable away from the connector and place the RF shield aside. Remove the ferrite bead from the ribbon cable and place it aside. Turn the chassis over and remove the two knobs with a 5/64” hex Allen key. Remove the two shaft hex nuts and washers. With a sharp pointed object, pry up the upper right corner of the membrane switch and slowly peel it away from the chassis.

Install the replacement membrane switch by peeling the adhesive cover away. While holding it by the edges, thread the ribbon cable through the slot on the top and slowly line up the edge with the recessed area of the chassis. Slowly swing it down from top to bottom to preserve the alignment with the recessed area of the chassis and press it firmly into place by wiping the membrane panel with a balled up tissue or cloth. Reattach the washers and hex nuts to the controls and attach the knobs. Turn the chassis over and thread the ferrite bead over the ribbon cable. Carefully position the shield so that the ribbon cable threads through it and insert the tail of the ribbon cable into the chassis connector until it seats. Push the plastic connector shroud against the connector until it clicks, binding the ribbon cable firmly. Reposition the shield over the standoffs and reinsert the mounting screws. Reassemble the chassis with the screws removed earlier.

Replacing the Main Circuit Board

Place the chassis top face down on a clean surface and provide a support at the chassis top so that the front panel knobs are clear of the table surface. Remove the five Phillips head screws that hold the internal RF shield in place. CAREFULLY lift the shield away from the chassis so that it pivots up and away from the circuit board underneath. Observe that the ribbon cable for the membrane panel protrudes through the shield. With a small flat screw diver push the left and right retaining tabs on the ribbon cable connector on the main circuit board up until they click, indicating that the ribbon is now free. Pull the ribbon cable away from the connector and place the RF shield aside. Remove the ferrite bead from the ribbon cable and place it aside. Disconnect the split power supply cable from the main circuit board. Disconnect the two stimulation output cables. Disconnect the coaxial cable BNC connector from the ultrasound output connector. Using a hex

socket driver, remove the five standoffs that are screwed to the board taking careful note of their location. Remove the remaining Phillips head screws that mount the board. Lift the board out and away from the chassis.

Using ESD handling precautions, remove the main board assembly from its protective container. Reposition the board in the chassis so that it lines up with the mounting holes. Reinsert the Phillips head screws that were removed earlier. Reattach the standoffs to the bolts protruding through the main board and tighten until firm. Reconnect the two stimulation output cables and the ultrasound output connector BNC. Carefully position the shield so that the ribbon cable threads through it and insert the tail of the ribbon cable into the chassis connector until it seats. Push the plastic connector shroud against the connector until it clicks, binding the ribbon cable firmly. Reconnect the power cable connectors to the connectors on the main board. Reposition the shield over the standoffs and reinsert the mounting screws. Reassemble the chassis with the screws removed earlier.
Verify the proper operation of the unit.

Replacing a Stim Output Connector

To replace a damaged stimulation output connector, first identify the connector to be replaced, looking into the chassis while it is lying open. Unplug that connector from the main board. Using a pair of long nosed channel lock pliers, grip the connector retaining ring and loosen it until it can be removed by using fingers. Thread the wire of the replacement connector through the front panel hole and slip the retaining nut ring over it inside the chassis. Start the nut ring onto the connector back until it binds while observing that the connector is properly rotated so that it engages the notch in the chassis. Use the channel lock pliers to tighten the ring. Plug the connector into the main board. Reassemble the chassis.
Verify the proper operation of the unit.

Replacing the Ultrasound Output Connector

To replace a damaged ultrasound output connector, disconnect the BNC connector end of the cable from the main board. Grab the black plastic connector shroud with a pair of pliers and slowly pull it away from the shoulder washer it is wrapped around. Loosen the nut now accessible using the same pliers and remove the nut and cup washer. Remove the cable assembly.

Insert the BNC connector through the panel hole, slip the cup washer, lock washer and mounting nut over the threaded shaft and tighten the nut. Push the black plastic connector shroud over the cup washer until it is snugly placed. Reconnect the BNC connector to the main board.

Verify the proper operation of the unit.

Section 12—Parts List

Part Number	Part Description
QT3-02	Main Board Assembly
HH3-01	Power Supply Board Assembly
FA1-11	Fuse, 5 x 20mm, 4A
WKR9-00	Case Top
HG1-22	Membrane Switch
PA7-91	Label, Output Jack
PA7-88	Label, Nomenclature
LJ5-01	Shield, EMI/RFI
KN1-24	Shield, HV Electrostatic Insulation
WKR9-01	Case Cover (Back)
WKR9-02	Bracket, Case Hold-down
QG2-06	Applicator Holder Assembly
KD5-01	Knob W/Finger Dimple
KB1-14	Cap, BNC Guard
JA6-15	Washer, Finishing Cap, BNC
KG1-15	Hole Plug, 11/16 Diameter
OE1-05	Fan Finger Guard
KA1-03	Rubber Foot
QS6-01	Fan Assembly
HH1-03	Switch, Rocker Power
HH2-15	Filter, Power Inlet
QR1-74	Cable Assembly, Power Supply
QT2-11	Cable Assembly, Output Jack, 4”
QT2-10	Cable Assembly, Output Jack, Shielded
QR1-75	Cable Assembly, Isolated Coax
QR1-76	Cable Assembly, Power Inlet
QR4-01	Cable Assembly, Power In Ground
QT2-14	Wire Assembly, Filter, Hot Wire
QT2-13	Wire Assembly, Filter, Neutral Wire
JB1-24	Screw, 6-32 x ¼”
JB1-25	Screw, 6-32 x 3/8”
JB2-27	Screw, Flat Head, 6-32 x 1-1/2”
JB1-23	Screw, 8-32 x ½”
JC2-03	Nut, 6-32
JC7-03	Nut, 8-32
KL3-01	Support, PCB (Standoff)
QN1-10	Crystal Ring Assembly, 5 cm^2 x 1 or 3.2 MHz (*for ME 7513 applicator)*
QR1-83	Applicator Handle Assembly, 5 cm^2 x 1 or 3.2 MHz (*for ME 7513 applicator), with domestic labeling*
QR1-84	Applicator Handle Assembly, 5 cm^2 x 1 or 3.2 MHz (*for ME 7513 applicator), with CE labeling*
KF1–13	O–Ring, 1.114", 5 cm^2 x 1 or 3.2 MHz (*for ME 7513 applicator)*

Section 13—Accessories

13.1 Ordering Information:

Therapy products and accessories are available from Mettler Electronics authorized Distributors. For information regarding either Mettler products or a distributor near you, please call toll free, (800) 854–9305 or phone (714) 533–2221 in areas outside the continental United States. Ask for Customer Service. Mettler Electronics is open from 7 AM until 5 PM Pacific Time for your convenience.

13.2 Sonicator Plus 992 Accessories

Catalogue #	Item Description
1844	Sonigel—salt free colloidal water couplant, case of 12, 9.5 oz. tubes
1851	Sonigel clear gel couplant, (12 x 250 ml)
1852	Sonigel clear gel couplant, (1 x 5 liters)
1853	Sonigel clear gel couplant, (4 X 5 liters)
1855	Sonigel Lotion ultrasound couplant and massage lotion, (1 X 5 liters)
1856	Sonigel Lotion ultrasound couplant and massage lotion, (4 X 5 liters)
1858	Sonigel Lotion with Aloe Vera, ultrasound couplant and massage lotion, (1 X 5 liters)
1859	Sonigel Lotion with Aloe Vera, ultrasound couplant and massage lotion, (4 X 5 liters)
2000	4 Sponge electrodes (2" x 2")
2001	24 Sponge inserts (2" x 2")
2002	4 Sponge electrodes (4" x 4")
2003	24 Sponge inserts (4" x 4")
2004	1 Sponge electrode (3.5" x 7")
2005	12 Sponge inserts (3.5" x 7")
2006	1 Sponge electrode (8" x 10")
2007	12 Sponge inserts (8" x 10")
2008	4 Electrode straps (24")
2009	4 Electrode straps (48")
2012	Bifurcated cord set
2023	Pencil electrode set with push button stimulation control, (includes handle, 4 different sizes of stainless steel spot electrode tips, and carrying case), *domestic units only*
2027	Pin to banana adapter plug set to be used with ME 2026, 2260, 2261 or 2201 electrode cables. Four each, gray.
2260	Electrode cable for the Sonicator Plus 992 or 992 with pins
2261	Single cord electrode cable for the Sonicator Plus 992 or 992 for combination therapy
2221	EZ Trode – 2" diameter round self–adhering, reusable electrodes with lead wires; case of ten packages (four electrodes/pkg.)
2222	EZ Trode – 3" diameter round self–adhering, reusable electrodes with lead wires; case of ten packages (four electrodes/pkg.)

2223	EZ Trode – 2" x 5" self–adhering, reusable electrodes with lead wires, case of 10 packages (2 electrodes/pkg.)
2701	V Trode – 1.25" diameter round electrodes with lead wires, case of ten packages (four electrodes/pkg.)
2702	V Trode –2" diameter round electrodes with lead wires, case of ten packages (four electrodes/pkg.)
2703	V Trode –2.75" diameter round electrodes with lead wires, case of 10 packages (four electrodes/pkg.)
2704	V Trode –2" x 4" oval electrodes with lead wires, case of 10 packages (four electrodes/pkg.)
2705	V Trode –2" square electrodes with lead wires, case of 10 packages (four electrodes/pkg.)
7293	Detachable U.L. listed, hospital–grade line cord
7296	Detachable line cord, CE units
7305	Sonicator 715, 730, 992 and 994 applicator (5 cm^2/ 1 MHz)
7310	Sonicator 716, 730, 992 and 994 applicator (10 cm^2/ 1 MHz)
7331	Sonicator 730, 992 and 994 pencil style applicator (1 cm^2/ 3.3 MHz)
7335	Sonicator 730, 992 and 994 applicator (5 cm^2/ 3.3 MHz)
7392	Hooded, water-proof universal applicator cable for the Sonicator Plus 992 and 994
7513	Sonicator Plus 992 and 994 applicator (5 cm^2/ 1 or 3.2 MHz)
93	Deluxe mobile therapy cart
931	Slanted bracket accessory for ME 93 cart to mount one additional Sonicator or Sys∗Stim unit on the ME 93 cart pedestal.
933	Extra storage basket for ME 93, deluxe mobile therapy cart

Appendix A

Measuring Ultrasound Power Output

OHMIC Instruments ultrasound power meters, UPM–series, are traceable to National Institute of Science and Technology (NIST) standards. The UPM–DT–1 is recommended as first choice for measuring applicator output.

Whatever instrument is chosen to make these measurements, some basic principles apply to all. Degassed water must be the medium for ultrasound. Water used in ultrasound power meters must be degassed to less than 4 PPM (dissolved oxygen) for reliable results and adherence to FDA measurement requirements.

Mettler Electronics Corp. developed a good method for degassing water using a canning technique involving a pressure cooker and Mason jars. This is easier than boiling water for 30 minutes and transferring it to plastic bottles while still hot, then placing the bottles in a refrigerator. If interested in this method, send a request to the Mettler QA Department.

Also, when measuring ultrasound output, insure accurate placement of the applicator face over the center of the power meter target. If off center, the target will be moved around by ultrasound resulting in unstable readings.

Ultrasound output measurements should be taken in a stable environment, i.e., no air conditioning drafts across the power meter surface, and no vibrations shaking the power meter mechanism. These influences cause unstable readings and reduce reading repeatability.

Insure the power meter is zeroed between readings to verify a stable reference.

Finally, it is recommended that three sets of readings be taken and the average determined to obtain a more accurate representation of device performance. This helps minimize the effects of measurement variables.

Appendix B

Ultrasound Applicator Repair

1. Figure B.1 shows the ME 7513 applicator top assembly. It is representative of all the Sonicator 992 applicators.
2. Applicator components include: transducer ring assembly and handle assembly.
3. Replacement crystal ring and applicator handle assemblies may be installed by Mettler authorized repair facilities only. **(Unauthorized repairs void warranty provisions.)**
4. Applicators may be returned to the factory Service Department for repair if desired.

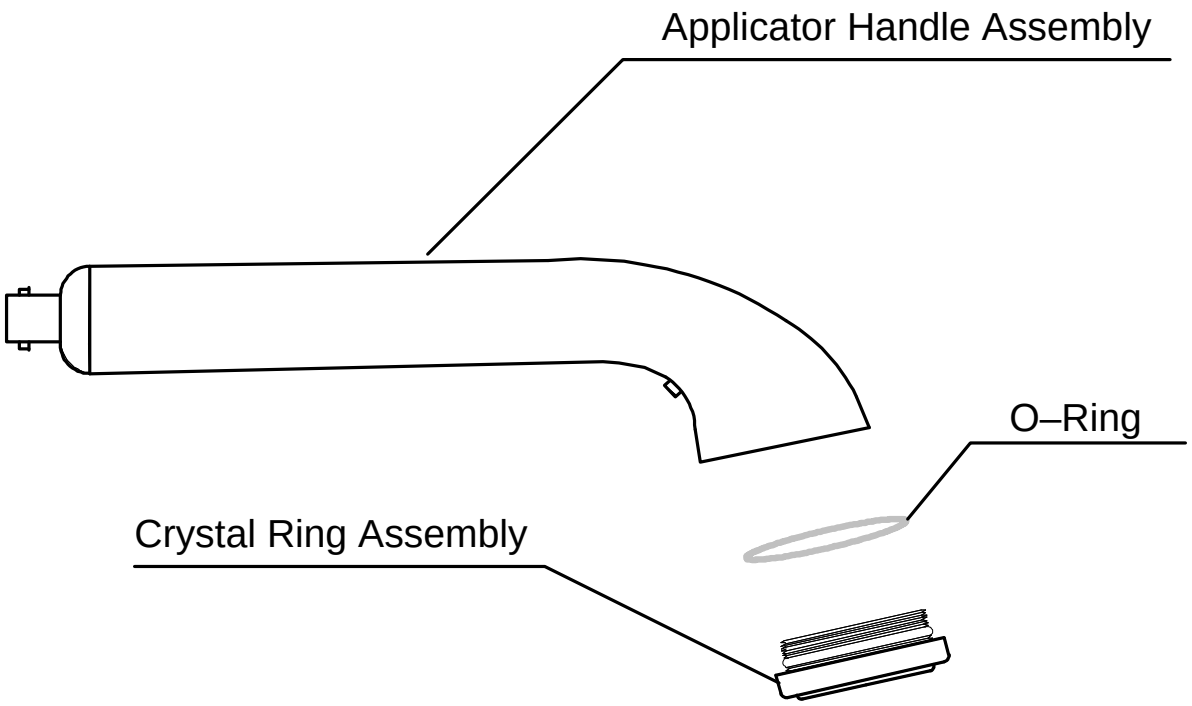


Figure B.1—Applicator Top Assembly

Appendix C

Result Codes for Keyboard Test:

Key	#	Key	#	Key	#
1	1	US Timer	21	Surge	41
2	2	MHz	22		
3	3	W:W/cm^2	23		
4	4	%	24		
5	5	Interferential	25		
6	6	Premodulated	26		
7	7	Medium Freq	27		
8	8	Biphasic *(TNS)*	28		
9	9	High Volt	29		
0	10	Micro Current	30		
Go	11	Sweep	31		
Hold	12	Rotate	32		
Stop	exits	Bip uS	33		
Stim	14	Bip Hz	34		
Ultrasound	15	HV Polarity	35		
Combination	16	HV Hz	36		
Timer 1	17	uC Polarity	37		
Timer 2	18	uC Hz	38		
N/A	19	Continuous	39		
N/A	20	Reciprocate	40		